Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

Contract Package SYS-1: Design, Supply, Installation, Testing & Commissioning of 2x25kV, 50Hz, AC, High Rise Overhead Electrification (OHE), Power Supply System and SCADA in connection with laying of New BG Double Railway Line from Prithla to New Harsana Kalan of Haryana Orbital Rail Corridor (HORC) Project from Km (-)2.14 to Km 125.98 Including Rigid Overhead Conductor System (ROCS) in Tunnel Portion i.e. from km 24.850 to km 29.580 and its connectivity to IR/DFC networks at New Prithla, Patli, Sultanpur, Asaudah and New Harsana Kalan including modifications in New Prithla, Sultanpur, Asaudah and New Harsana Kalan Station Yards (approximately 145 RKM and 320 TKM).

Part 2- EMPLOYER'S REQUIREMENTS

SECTION VII-1
GENERAL SPECIFICATIONS (GS)

Table of Contents

Section VII-1: GENERAL SPECIFICATIONS

TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION & SCOPE

1.1 INTRODUCTION

1.1.1 Haryana Rail Infrastructure Development Corporation Limited (HRIDC) was Incorporated on 22nd August 2017 as a Joint Venture between Government of Haryana and Ministry of Railways with equity Participation of 51% and 49% respectively. The Haryana Orbital Rail Corridor (HORC) project is from Prithla (near Palwal station of Indian Railways) to New Harsana Kalan (near Sonepat station of Indian Railways) of HRIDC.

1.1.2 Haryana Orbital Rail Corridor (HORC) route will be approximately 145 RKM and 320 TKM from Prithla to New Harsana Kalan including connectivity to Indian Railway (IR) and Dedicated Freight Corridor Corporation of India Limited (DFCCIL) stations.

1.1.3 There are 17 New Stations namely Prithla, Silani, Sohna IMT, Dhulawat, Chandla Dungerwas, Panchgaon, Manesar, New Patli, Badsa, Deverkhana, Badli, Mandothi, New Asaudah, Jasaur Kheri, Kharkhoda, Tarakpur and New Harsana Kalan.

1.1.4 Out of 17 stations, 4 are Junction Stations namely Manesar, New Patli, Badsa and Mandothi and are proposed with proper connectivity with IR stations. The Prithla station (HORC) with High Rise OHE is connected by double lines with New Prithala station of DFCCIL with High Rise OHE and also to DFCCIL line at Prithla with single line, New Patli station (HORC) with High Rise OHE is connected by single line with IR Patli station with High Rise OHE at chainage 3.000 km (from Ch 0.000 km at New Patli station). The New Patli station (HORC) with High Rise OHE is connected by single line to Sultanpur station (IR) with High Rise OHE. Sultanpur (IR) station with High Rise OHE is connected by single line to Badsa station with High Rise OHE. Mandothi station (HORC) with High Rise OHE is connected by single line with Asaudah station of IR with normal OHE. The Manesar station (HORC) with High Rise OHE is connected with the Maruti Suzuki factory siding with High Rise OHE and also connected with IR Patli station with High Rise OHE and work is being executed by another agency. The proposed double lines (HORC) will be ending at New Harsana Kalan station. The new Harsana Kalan (HORC) station (with High Rise OHE) shall be connected by double lines with Harsana Kalan station of IR with normal OHE).

1.1.5 The Proposed Corridor between New Prithla – New Harsana Kalan having a total of approx. 145 RKM and 320 TKM. The Section is proposed to be electrified with 2x25 kV, AC, 50 Hz, High Rise OHE. Rigid Overhead Conductor System (ROCS) shall be provided in twin tunnels from km 24.850 to km 29.580 between IMT Sohna and Dhulawat ststion. here is viaduct between Sohna IMT station and tunnel from km 21.345 to km 24.849.

1.1.6 The bridges and formation will be designed for 32.5T axle load while the track structure will be designed for 25T axle load operating at train speed of up to 160 Kmph. There shall be 3 RFOs (Railway Fly Overs) over Delhi -Rewari, BG, Double Line, Electrified with High Rise OHE at Patli; over Garhi Harsaru – Farukh Nagar, BG Single Line, Electrified with High Rise OHE at Sultanpur; and Delhi – Rohtak, BG, Double Line, Electrified with normal OHE at Asaudah.

1.1.7 The proposed HORC Railway Lines shall handle Goods as well as Passenger traffic.

1.2 OBJECTIVE

1.2.1 The objective of the Bid document is execution of design, manufacture, supply, construction, installation, testing and commissioning of High Rise 2x25kV, 50Hz, AC, Electric Traction System, Power Supply System, Overhead Equipment (OHE) & Rigid Overhead Conductor System(ROCS), Supervisory Control & Data Acquisition (SCADA) System, Single Phase 240V power supply by installing 25kV/240V auxiliary transformers at signal & telecom huts, and stations including other associated works for New Prithla to New Harsana Kalan of the HORC Project, as a Design and Build Package.

1.3 PROJECT INFORMATION FOR PRITHLA – NEW HARSANA KALAN SECTION

Section	HORC Chainage		Approx. Total Route Length	Remarks
	From	To		
Package SYS-1 : Pirthla – New Harsana Kalan and connectivity at New Prithla, Prithla, Sultanpur, Asaudah and New Harsana Kalan	Km (-)2.14	Km 125.98	Km - 145	Tunnel from km 24.850 to km 29.580

1.3.1 Station Buildings, Depots and Service Buildings

The list of Station Buildings, Depots and Service Buildings in the Pirthla – New Harsana Kalan section are detailed as under:

(1) JUNCTION STATIONS

There are 4 junction stations in this section namely Manesar, New Patli, Badsa and Mandothi.

(2) CROSSING STATIONS

The list of Junction stations and Crossing stations along with their indicative chainages is as detailed below:

SN	Station	Chainage (km)
1	Prithla	0.00
2	Silani	10.40
3	Sohna IMT	19.01
4	Dhulawat	32.77
5	Chandla Dungerwas	42.60
6	Panchgaon	46.29
7	Manesar	51.89
8	New Patli	58.00
9	Badsa	64.75
10	Deverkhana	71.14

11	Badli	76.83
12	Mandothi	90.45
13	New Asaudah	94.03
14	Jasaur Kheri	100.22
15	Kharkhoda	108.72
16	Tarakpur	114.20
17	New Harsana Kalan	125.13

1.3.2 The OHE and PSI Depot for maintenance shall be constructed at Manesar by other contractor.

1.3.3 LEVEL CROSSINGS

There are no Level Crossings in the works.

1.3.4 The salient features of the Track Structure and Formation on Prithla – New Harsana Kalan of HORC are as follows:

Sr.	Description	Details & Particular
1.	Gauge	1676 millimeters
2.	Main Line, Loops and Sidings	60 kg/M Rail, 1 in 12 curved thick web switches with CMS Crossings on Fan shaped PSC Sleepers layout
3.	Sleepers	PSC Mono-Block, 60 kg/M
4.	Formation Width a) Embankment (Straight Track) b) Cuttings (Straight Track) excluding side drains	 For Double line : 13160 mm minimum For Single line : 7850 mm For Double line : 13160 mm minimum For Single line : NA
5.	Radii of curves	Shall generally be not less than 700 meters on main lines (2.5 degrees)
6.	Maximum gradient	1:200 compensated
7.	Slope Gradient for Ballast Section	As per RDSO GE: IRS-0004
8.	Cross Slope on top of formation	1 in 30
9.	Formation	As per guidelines and specifications for design formation for Heavy (32.5 T) Axle Load stipulated by GE: IRS – 0004.
10.	Ballast Cushion a) Main Line b) Loop Line and sidings	 350 millimeters 250 millimeters
11.	Bridges	32.5 T Axle Load

1.3.5 Operation Control Center Facilities

1) A Centralized Operational Control Centre (OCC) for entire HORC shall be located at Manesar. The OCC shall house the 'Train Management System' 'Traction Power SCADA' and 'Auxiliary SCADA' Control for HORC. All the controllers such as Traffic Controllers, Track Controller, Traction Power Controllers, and Signal Fault Controller etc. shall monitor and manage all train operations and associated activities, including maintenance of entire HORC from the OCC.

1.4 CONTRACT PACKAGES FOR PIRTHLA - NEW HARSANA KALAN SECTION

1.4.1 The work of Pirthla – New Harsana Kalan Section has been divided in different packages as under:

SN	Contract Package	Contractor	Area Chainage km
1	C-5	Civil (without track) and Electrical General	(-)2.11 to 24.40
2	C-4	Civil Tunnel (with track) and Electrical General	24.40 to 29.14
3	C-23	Civil (without track) and Electrical General	29.14 to 49.70 and 55.60 to 61.50
4	C-1	Civil (without track)	49.70 to 55.60
5	C-6	Civil (without track) and Electrical General	61.50 to 125.98
7	T-1	Track	Cover C-1 and C-23 section
8	T-2	Track	Cover C-5 and C-6 section
9	BR-1	Bridge	Pataudi Road at km 54
10	SYS-2	Signalling and Telecommunications	Entire section from Prithla to New Harsana Kalan
11	SYS-1	Electrical (PSI, OHE and SCADA)	Entire section from Prithla to New Harsana Kalan
12	MSIL(OHE)	OHE	MSIL to Manesar station to Patli (IR) station

1.5 SCOPE OF WORK

1.5.1 The Scope of Work is comprised of Design, Manufacture, Procure/Supply, Construct/Install, Build, Testing and Commissioning of 2x25kV AC Electrification and associated Works, as required for safe and reliable operation for Pirthla – Harsana Kalan section of HORC. The details of track sections, stations, LC gates, Maintenance depots, OCC, service buildings etc covered under HORC are given in clauses above. The Work shall be executed based on "Employer's Requirements" as detailed in this "**General Specifications**" and the "**Particular Specifications**" as specified below and other documents included in this Bid:

a. Section VII-1: General Specifications,

It describes the Employer's General Requirement for execution of the 2x25kV AC Electrification and associated woks for Pirthla – New Harsana Kalan section of HORC.

b. Section VII-2: Particular Specifications-2x25kV, AC, Traction Electrification and associated Works, It describes the Employer's Requirement and the scope of work for execution of 2x25 kV, AC, Traction Electrification and associated works for Pirthla – New Harsana Kalan section of HORC.

c. Section VII-3: Drawings and documents

It contains the list of drawings and documents required for the works of HORC.

1.5.2 Permanent Works

All works required for Electrification (2x25 kV) and associated works for Pirthla – New Harsana Kalan section as per the details identified in Section VII-1,2 &3 of this document except temporary works are required for facilitation and delivery.

Note*: - Construction of Traction Sub stations, Switching Stations and Auxiliary substations works and SCADA are also part of this Contract Package.*

1.5.3 Temporary Works

(1) The Contractor shall execute all Temporary Works required to facilitate construction/Installation of permanent works.

(2) All temporary arrangements and Works shall be designed and necessary drawings developed to ensure that these remain safe during construction/Installation.

(3) As a rule, temporary Works shall be subsequently dismantled and removed by the Contractor after construction/installation, at his own cost. The Engineer, however, may permit retention of some of the temporary works with mutual consent between the Contractor and the Engineer.

1.5.4 Approvals / Clearance And Certification

The Contractor shall be fully responsible for timely planning and obtaining;

(1) Relevant certificates, approvals or clearances from local/civil authorities viz. completion certificate, fire clearance or any other mandatory clearances as required,

(2) All necessary approvals for the drawings including General Arrangement Drawings (GADs) from the concerned Railway/ State/ Local authorities before the commencement of construction,

(3) Relevant certificate(s) and/ or clearance(s) from local / civil authorities/ Commissioner of Railway Safety (CRS)/ Electrical Inspector to the Government of India (EIG) / Dot Clearance.

(End of Chapter 1)

CHAPTER 2 - GENERAL

2.1 DEFINITIONS AND INTERPRETATIONS

In addition to the words and expressions defined in the Conditions of Contract, following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

(1) **"As-Built Documents"** means those drawings & documents produced by the Contractor and endorsed by it as true records of construction/Installation of the Permanent Works and which have been agreed with the Engineer.

(2) **"Auxiliary Signals"** Shunt signals – Independent or below Main Signals, Calling- on signals, Route indicators, 'A' marker & 'AG' marker lights for Semi-Automatic signals.

(3) **"Availability"** The probability that an item will be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided.

(4) **"Apportionment"** process whereby the RAMS elements for a systems are sub- divided between the various items which comprise the system to provide individual targets.

(5) "Chainage" means a term often used for all Indian Projects. It is not a unit of measurement. It merely denotes the location of any particular point on DFCC/IR alignment. For example, the location of a point is 23.502 denotes the location of a point is at a distance of 23502 metres from the zero point. In Indian parlance 23.502 is termed as "Chainage" of that point.

(6) **"Combined Services Drawings"** means drawings showing the services details of all the Utilities in a combined drawing indicating locations, layouts and sizes of all electrical and mechanical services.

(7) **"Compliance"** demonstration that a characteristic or property of a product satisfies the stated requirements.

(8) **"Condition of Contract"** shall means General Conditions of Contract read in conjunction with Particular Conditions of Contracts as in Part 3 of Bidding Documents.

(9) **"Commencement Date**'' means the date of as defined in Particular Conditions of Contract.

(10) **"Construction/Installation and/or Manufacture Documents"** means all documents ,drawings, calculations, computer software, samples, patterns, models, operation and maintenance manuals and other manuals and information of a similar nature submitted by the Contractor.

(11) **"Construction/ Installation Drawings"** shall be derived directly from the Detailed Design and shall detail and illustrate in full the Permanent & Temporary Works. These drawings /documents are the ones which the Contractor considers sufficient in detail for construction/Installation and is cleared by the Engineer for construction/Installation.

(12) **"Control Terminal"** An Industrial grade computer completes with hard disc, VDU display monitor, key board and mouse, as required.

(13) **"Corrective Maintenance"** means maintenance performed to correct the occurrence of an equipment or system fault.

(14) **"Defect"** is any part of the Work which is not in accordance with the Contract.

(15) **"Detailed Design"** prepared and accepted part of drawings, documents, standards and instructions which is the authorization for manufacture, Procure/supply, construction/Installation and testing. "Detailed Design" has the meaning identified in

Chapter-6 of this GS.

(16) **"Detailed Design Submission"** means the submission of Contractor's Documents which comprise the whole or part(s) of the proposed Detailed Design and for which the Contractor seeks a Notice.

(17) **"Design Criteria"** means the governing specifications and conditions as specified in Employer's Requirements as detailed in GS and PS.

(18) **"Design Data"** means all survey and investigations, specifications, plans, drawings, details, graphs, sketches, models, levels, setting-out dimensions, calculations and other documents related to the design of the Works.

(19) **"Design life"** The design life is the period of time during which the system is expected to work satisfactorily within its specified parameters.

(20) **"Design Manual"** means the manual to be prepared and submitted by the Contractor as part of the Preliminary Design and as described in Chapter-6 of this GS of the Bidding Documents as applicable.

(21) **"Design Phase"** has the meaning identified in Chapter-6 of This GS.

(22) **"Designer"** means the Contractor or part of the group forming the Contractor, person, firm or company or group of companies or any replacement carrying out the Design of Works or part thereof.

(23) **"Down Time"** time interval during which a product is in a down state.

(24) **"Drawings"** means the Employer's Indicative Drawings and the Drawings submitted by the Contractor and modification of such drawings, if any, furnished from time to time or for which the Engineer has issued a Notice of No Objection.

(25) **"Employer"** means the Haryana Rail Infrastructure Development Corporation Limited (HRIDC) or the person named as Employer and the legal successors in title to this person.

(26) **"Employer's Personnel"** means the person so authorized for the purpose of Contract Execution.

(27) **"Employer's Representative"** means the person so authorized by the Employer for the specific purpose of Contract Execution.

(28) **"Engineer"** means the person so authorized for the purpose of Contract Execution.

(29) **The "Engineer"** means the General Consultant (GC) Representative / the person appointed by the Employer to act as the Engineer for the purposes of the Contract or other person appointed from time to time by the Employer and notified to the Contractor.

(30) **"Factory Acceptance Tests"** Type/Routine/ acceptance/special Tests as specified in relevant standards & specifications as needed before dispatch of material and conducted at the premises of Original Equipment Manufacturer.

(31) **"Failure Mode"** predicted or observed results of failure cause on a stated item in relation to the operating conditions at the time of the failure.

(32) **"Flank Protection"** Protection of a train running on route set for it from trains or vehicles on neighboring lines through setting & locking of concerned points in required position is called Flank protection.

(33) **"Hazard"** Physical situation with a potential for human injury and / or damage to environment.

(34) **"Interfacing Contractor"** means the Contractor engaged by the Employer or other agencies having an interface issue with the Contractor for this Work.

(35) **"Interfacing Parties"** comprises of the designated contractors/ consultants/ service providers, other Contractors who are engaged in part of the works and relevant statutory authorities, relevant public utility agency and adjacent contractors who are or will be working adjacent to the site.

(36) **"Interface coordinator"** is an official appointed by the contractor to Coordinate the Interface requirement and organize the interaction between interfacing parties and organize interface.

(37) **"Interface Manager"** Is the official appointed by the contractor, directly Responsible to identify, assess the interface requirement with other systems and incorporate in the Detailed Interface Designs to identify the boundaries of responsibilities, get it agreed with interfaced parties and manage the interface requirement within its agreed scope.

(38) **"Level Crossing"** Is the rail – road surface crossing.

(39) **"Line Replaceable Unit (LRU)"** means equipment that can be replaced as a single complete unit and can be handled by a single person.

(40) **"Main running signals"** Home signal, Starter signal, Intermediate Starter signal, Advance Starter signal and Gate signals.

(41) **"Maintainability"** A characteristic of design and installation, expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.

(42) **"Man Machine Interface (MMI)"** means the visual interface between the Controller and the control system. The MMI consists of the computer screen, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.

(43) **"Mean Time to Restore (MTTR)"** means the average time to restore equipment, subsystems, system to full functionally.

(44) **"Milestone"** means as defined in Particular Conditions of Contract in Part 3 of Bid Document.

(45) **"Milestone Date"** means the date, prescribed in Particular Conditions of Contract in Part 3 of Bid Document, by which a Milestone is to be achieved.

(46) **"Milestone Certificate"** means the certificate to be issued by the Engineer in relation to the achievement or otherwise of Milestones.

(47) **"Notice"** means a Notice of No Objection.

(48) **"Other Contractor"** means Contractor(s) other than that for this package i.e. SYS-1.

(49) **"Outline Quality Plan"** means the quality plan setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to quality assurance as prescribed in the Employer's Requirements.

(50) **"Outline Safety Plan"** means the safety plan setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to construction/Installation safety as prescribed in the Employer's Requirements.

(51) **"Operating Hours"** means operating hours for Train Operation in EDFC.

(52) **"Particular Specification"** means the Specifications prepared for the purpose as enclosed in Part – 2, Section VII-2.

(53) **"Permanent Work''** means the permanent works to be designed and executed by the Contractor under the scope of work covered in this GS and relevant PS.

(54) **"Plan"** means a scheme or method or procedure statement/ document of doing/ proceeding

/ making developing in advanced to achieve a desired goal/ objective within a specific time frame.

(55) **"Preliminary Design"** means the submission of Contractor's Documents which comprise the initial stage of the design phase. It is a basically a concept scheme design.

(56) **"Preliminary Drawings"** means the drawings prepared by the Contractor that are built on the Reference Drawings and accompany the Contractor's Preliminary Design submissions.

(57) **"Program"** means a time schedule or Program or Program which has been developed for delivery of a particular purpose or any activity in a time a frame. It is same as "Program".

(58) **"Pull-down Menu"** means a list of items displayed by clicking mouse, arranged in the downward direction.

(59) **"Pull-up Menu"** means a list of items displayed by clicking mouse, arrange in the upward direction.

(60) **"Possession"** means taking a section of the IR line(s) out of service.

(61) **"Railway"** means Railway or any portion of a Railway for public carriage of passengers and goods including dedicated freight corridors.

(62) **"Railway Envelope"** means the zone or zones which contain the track, platforms and equipment necessary for the operation of the railway by the HORC.

(63) "**Reference Drawings"** means the drawings prepared by the Employer and included in the bidding document.

(64) **"Reliability"** The probability that an item/equipment/system can perform a required function under given conditions for a given time interval.

(65) **"Reliability growth"** means a condition characterized by a progressive improvement of a reliability performance measure of an item with time.

(66) **"Right of Way''** means the width/area of the land acquired/being acquired for the operation of the railway. Right of way for HORC project has been indicated in Part -2, Section VII-3: drawings and documents.

(67) **"Running Lines"** The Indian Railway Lines at connecting stations.

(68) **"Safety"** Freedom from unacceptable risk.

(69) **"Safety Integrity Level"** means a number identifying discrete level for specifying the safety integrity requirements of the safety functions to be allocated to the safety related systems. Safety Integrity Level with the highest figure has the highest level of safety integrity.

(70) **"Safety-Critical"** means failure of the system, sub-system or equipment that directly leads to a situation with the potential to cause harm, injury to humans, damage to property, plant or equipment, damage to the environment, or economic loss.

(71) **"Safety Procedures"** these shall be the procedures as detailed in Chapter-9: "Site Safety Plan" of this GS.

(72) **"Schedule of Milestones"** means the schedule included Part-3 of Bid Document.

(73) **"Site''** means the area where the Permanent Works are executed in the Right of Way or adjoining the Right of Way.

(74) **"Stations"** means Railway stations belonging to IR or HORC.

(75) **"System Acceptance Tests''** means those tests that demonstrate the performance of the installation / equipment to the specified requirements as detailed in the Particular Specifications.

(76) **"System Contractor"** means the Contractor engaged by the Employer to carry out Works related to Systems part of the project.

(77) **"System Works"** means the works to be carried out by the Contractor(s) engaged by the Employer to carry out Works related to 'Design, Construct/Install, Manufacture, Procure/Supply, Build, Testing and Commissioning of 2x25kV AC Electrification and associated woks' as part of the project for the HORC Railway line under construction on Design-Build lump sum basis from Pirthla – New Harsana Kalan Section of HORC including removal of any temporary works as included in the scope of Work of the Employer's Requirement.

(78) **"Technical Specifications"** means the combined specifications prepared by the Contractor in a format which combines the Technical Specifications and those parts of the Contractor's Technical Proposals which specify standards for design, procurement, manufacture, Procure/supply construction/Installation, testing and commissioning which are developed during the Design Phase and fully comply with the Employer's requirements.

(79) **"Temporary works"** means all Temporary Works of every kind (other than Contractor's Equipment) required on Site for the execution and completion of the Permanent Works and the remedying of any defects.

(80) **"Train Operator/Driver"** means the person(s) on the trains responsible for its operation.

(81) **"TMS terminal"** A terminal having MMI device with video display unit (VDU), Keyboard and mouse.

(82) **"Validation"** means confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled.

(83) **"Video wall"** A graphical representation of the 2x25 kV AC Traction Electrification, E&M and Train Management System and its global operating status.

(84) **"Works"** means the work, both permanent and temporary or services to be carriedout, survey and investigation, designed, manufactured, fabricated, delivered to Site, erected, installed, completed, tested, commissioned, (including Integrated Testing and Commissioning) or supplied in accordance with the Contract and include Plant, Equipment and Material and their accessories.

(85) **"Work Stations"** means the collection of processors, screens and input devices necessary to provide the controller or maintenance personnel with necessary system displays and commands.

(86) **"Working Drawings"** comprise the Construction reference drawings such as construction/Installation drawings, manufacturing drawings and testing and commissioning documents, as are necessary to amplify the Good for construction/Installation Drawings for construction/Installation etc. purposes and endorsed, as required by the Engineer.

(87) **"Works Program"** means the Program showing list of activities as per the sequence, Duration, start date, finish date, float/ cushion if any, method and timing of Verification/Investigations, design stages, submission date, Date for issue of No Objection Notices, execution (start/ finish), Procurement, manufacture, FAT, delivery to site, access hand over date, Development of Mockup, erection, installation, RAMS demonstration, testing, commissioning of the Works (including Integrated Testing and Commissioning), indigenization (where applicable) and related activities in the form and content prescribed by the Employer's Requirements, or any amended or varied version thereof, as submitted by the Contractor and for which the Engineer has issued a Notice of No Objection.

2.2 ABBREVIATIONS AND ACRONYMS

Abbreviation	Description
AC	Alternating Current
ACTM	AC Traction Manual
ASM	Assistant Station Master
Aux AT	Auxiliary Transformers
AT	Auto Transformer
ALARP	As Low as Reasonably Practicable
BS	British Standards
BIS	Bureau of Indian Standards
BTS	Base Transceiver Station
CAD	Computer Aided Design
CENELEC	European Committee for Electro Technical Standards
CHC	Chief Controller
CIP	Co-ordinated Installation Plan
CP	Contract Package
CPCB	Centre Pollution Control Board
CPM	Critical Path Method
CRS	Commissioner for Railway Safety
CSD	Combined Service Drawings
CST	Civil, Structure and Track
CV	Curriculum-Vitae
DC	Direct Current
DDF	Digital Distribution Frame
dB	Decibel
DCN	Design Change Notice
DFC	Dedicated Freight Corridor
DFCC	Dedicated Freight Corridor Corporation
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
DL	Double Line
DNP	Defect Notification Period
DPR	Detailed Project Report
DT	Down Time
DTN	Data Transmission Network
DVT	Design Verification Table
DVV	Design Verification and Validation
E & M	Electrical and Mechanical
EDFC	Eastern Dedicated Freight Corridor
EIG	Electrical Inspector to the Government of India

EI	Electronic Interlocking
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EMP	Environmental Management Plan
EN	Euro Norm
ERP	Enterprise Resource Planning
Excl.	Excluding
FAT	Factory Acceptance Test
FCN	Field Change Notice
FIU	Field Interface Unit
FMEA	Fault Mode and Effects Analysis
FMECA	Failure Modes Effect and Criticality Analysis
FRCAS	Failure Recording And Corrective Action System
FTA	Fault Tree Analysis
GE	Geotechnical Engineering
GSM-R	Global System for Mobile Communication – Railway
GWR	Gate Working Rules
G&SR	General and Subsidiary Rules
GAD	General Arrangement Drawing
GCC	General Conditions of Contract
GS	General Specification
HRIDC	Haryana Rail Infrastructure Development Corporation Limited
HORC	Haryana Orbital Rail Corridor
HT	High Tension
HTML	Hyper Text Markup Language
HAZOP	Hazard and Operability Studies
HF	High Frequency
HDD	Hard Disc Drive
HDPE	High Density Poly Ethylene
Hz	Hertz
ID	Identification
ICD	Interface Co-ordination Document
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electro – technical Commission
IHA	Interface Hazard Analysis
Incl.	Including
IMD	Integrated Maintenance Depot
IMSD	Integrated Maintenance Sub Depot
IMP	Interface Management Plan
INR	Indian Rupees

IPS	Integrated Power Supply
IR	Indian Railway
IRS	Indian Railway Standards
IRSEM	Indian Railway Signal Engineering Manual
IS	Indian Standard
ISO	International Standards Organization
IT	Information Technology
Km / KM	Kilo Meter
KMPH	Kilo Meter Per Hour
KV	Kilo Volt
KVA	Kilo Volt Ampere
LED	Light Emitting Diode
LT	Low Tension
LC	Level Crossing
LRU	Line Replaceable Unit
LIU	Line Interface Unit
M & P	Machines and Plants
MACLS	Multiple Aspect Colour Light Signalling
MCB	Miniature Circuit Breaker
MCIL	Maintainability Critical Items List
MDF	Main Distribution Frame
MDT	Mean Down Time
MTBSAF	Mean Time Between Service Affecting Failure
MMD	Maximum Moving Dimensions
MMI	Man Machine Interface
MOR	Ministry of Railway
MPR	Monthly Progress Report
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
MTTR	Mean Time To Restore
NABL	National Accreditation Board for Laboratories
NMCP	Noise Monitoring and Control Plan
NOC	No Objection Certificate
O & M	Operation and Maintenance
O&SHA	Operating and Support Hazard Analysis
OCC	Operations Control Centre
ODBC	Open Data Base Connectivity
ODF	Optional Distribution Frame
OEM	Original Equipment Manufacturer
OFC	Optic Fiber Cable

OHE	Over Head Equipment
OHTL	Over Head Transmission Lines
OPM	Other Preventive Measures
PBX	Private Branch Exchange
PC	Personal Computer
PHA	Preliminary Hazard Analysis
PMIS	Project Management Information System
PS	Particular Specifications
PVC	Poly Vinyl Chloride
QA	Quality Assurance
RAM	Reliability, Availability & Maintainability
RAMS	Reliability, Availability, Maintainability and Safety
RAP	Resettlement Action Plan
RBD	Reliability Block Diagram
RCIL	Reliability Critical Item List
RDSO	Research Design and Standards Organization
RDT	Reliability Demonstration Testing
RE	Railway Electrification
ROB	Road Over Bridge
ROW	Right Of Way
RUB	Rail Under Bridge
SAT	System Acceptance Test
SCIL	Safety Critical Items List
SCADA	Supervisory Control And Data Acquisition
SER	Signalling Equipment Room
SHE	Safety, Health and Environment
SIL	Safety Integrity Level
SL	Single Line
SM	Station Master
SOD	Schedule of Dimensions
SOGP	Schedule of Guaranteed Performance
SP	Sectioning & Paralleling Post
SSP	Sub Sectioning & Paralleling Post
SPM	Suspended Particulate Matter
SRS	System Requirement Specification
SSP	Sub-Sectioning Post
SSHA	Subsystem Hazard Analysis
S & T	Signaling & Telecommunication
SWR	Station Working Rules
TER	Telecommunication Equipment Room

T&P	Tools & Plants
TMS	Train Management System
TOT	Transfer of Technology
TPC	Traction Power Controller
TSS	Traction Sub Station
UIC	International Union of Railways
UPS	Uninterruptible Power Supply
VAT	Value Added Tax
VDU	Video Display Unit
VRLA	Valve Regulated Lead Acid
VHF	Very High Frequency
WGS	World Geodetic System

2.3 APPLICABILITY OF GENERAL SPECIFICATIONS AND RELEVANT DOCUMENTS

2.3.1 The provisions contained in the Particular Specification (PS) shall prevail over the provisions contained in this GS.

2.3.2 These documents shall be read in conjunction with the Conditions of Contract (General and Particular), Employer’s Requirement and any other document forming part of the Contract.

2.3.3 This design-build contract shall be fulfilled, managed and commissioned in accordance with the applicable legislation in India, specific IR regulations/ International/ National standards as specified.

2.4 REFERENCE DOCUMENTS

Reference Documents as relevant for the package i.e drawings, alignment plans etc are Part 2, Section VII-3.

2.5 CODES & STANDARDS

2.5.1 Equipment, material and systems/sub-systems shall be designed, manufactured and tested in accordance with the latest issue of approved and recognized codes and standards defined and proposed by the Contractor and approved for the Work. All standards, codes and manuals with correction slips issued up to 28 days prior to last date of first stage of Bid submission shall be applicable for this bid. Any other applicable code, circular, instruction of UIC shall be referred with the approval of the Engineer.

2.5.2 References to standards or to material and equipment of a particular manufacturer in these contract documents shall be regarded as followed by the words or equivalent.

2.5.3 The Contractor shall supply to the Engineer, two authorized and original full editions of the publications (such as, but not limited to, Technical Standards and Codes of Practice), the codes and standards proposed /used for carrying out the Designs, Contractor’s Documents, the Drawings and other communications relevant to this Contract. These publications shall be for the sole use of the Engineer and Employer and, upon completion of the Contract, shall become the property of the Employer.

2.5.4 The Contractor shall ensure that items of equipment and their components are standardized wherever possible throughout the Works where similar requirements and functions exist.

2.5.5 The Contractor shall submit design to the Engineer for review and no objection. The proposed standards used shall also be referred with the design listed in the Employer's Requirements. The Contractor may propose an alternative equivalent international standard during the design stage but the acceptance of the alternative standard shall be subject to review by the Engineer.

2.6 SCHEDULE OF DIMENSIONS AND CLEARANCES

2.6.1 The Permanent works shall not infringe the Standard Schedule of Dimensions (SSOD) of Indian Railways, 1676 mm Gauge, BG, Revised, 2022 (with latest Addendum & Corrigendum Slips) and land boundary limits of HORC as shown on the drawings as listed in Section VII-3.

2.6.2 In addition, the Contractor shall formulate all necessary drawings, plans, documents etc. in accordance with the applicable legislation in India, in compliance with the Contractor definitive design for all clearances.

2.7 SPECIFICATIONS

2.7.1 The **Technical Specifications** for the Work shall be in accordance with the requirement detailed in Part – 2, Section VII: General Specifications & Particular Specifications.

2.7.2 In accordance with the provisions of these documents, the Contractor shall develop the System Requirement Specifications (SRS) during the Design stage and submit along with the Inception Report. The SRS compliance shall be submitted as part of the Detailed Design Submission along with the Schedule of Guaranteed Performance (SOGP) proposed by the vendor of the equipment selected and as desired & approved by the Engineer.

2.7.3 When the Specifications have received a 'Notice of No Objection' from the Engineer, these shall become the Technical Specifications.

2.8 LANGUAGE OF CONTRACTOR'S DOCUMENTS

All documents, reports, drawings, calculations and correspondence and the like shall be submitted by the Contractor in English.

2.9 PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

2.9.1 The Contractor shall utilize a Proven PMIS such that all documents generated by the Contractor can be transmitted to the Engineer through electronic means and traceable.

2.9.2 The PMIS shall also allow all documents generated by either party to be electronically captured at the point of origin and be reproduced later, electronically and in hard copy.

2.9.3 The requirements of PMIS are explained in Chapter 15, Appendix-7- "PMIS Requirement and Procedures".

2.10 PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHTS

2.10.1 The patent, copyright or other intellectual property rights in any Plant, Design Data, plans, calculations, drawings, documents, material, know-how and information relating to the Works shall be vested with the Contractor. The Contractor shall grant to the Employer, his successors and assignees, a royalty-free, nonexclusive and irrevocable license to use and reproduce any of the Works, Designs or inventions incorporated and referred to in such plant, documents or material and any such know-how and information for all purposes relating to the Works, including without limitation, the design, manufacture, installation, reconstruction, testing, commissioning, completion, reinstatement, extension, repair and operation of the Works.

2.10.2 Infringement of Patent Rights

The Employer shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design and development of any system/sub system(s) or due to any other factor not mentioned herein which may cause a dispute. The entire responsibility to settle any such disputes / matters shall lie with the Contractor.

2.11 PUBLICITY

The Contractor / Sub-Contractor(s) shall not publish, present at seminars, forums or otherwise circulate, alone or in conjunction with any other person, any article, photograph or other material relating to the Contract, the Site, the Works, the Project or any part thereof, nor part with the Press, or any radio or television network, any information relating thereto, nor allow any representative of the media access to the Site, Contractor's Works Areas, or off-Site place of manufacture, or storage except with the permission, in writing, of the Employer. The provisions of this Sub-Clause shall not exempt the Contractor from complying with any statutory provision in regard to the taking and publication of photographs.

2.12 GUARANTEE/ WARRANTY CERTIFICATES OF OEM

All Original Guarantee/Warranty Certificates of OEMs should be registered in the name of HRIDC. These Guarantee/warranty certificates received from the OEMs should be passed on to HRIDC.

2.13 SURVEY AND SITE INVESTIGATIONS

The Contractor shall carry out all necessary surveys and all further site investigations as required for the design of the system works and to enable the determination of the methods of construction / Installation and the nature, extent and design of the Temporary Works.

It is Contractor responsibility to obtain all necessary permissions, approvals etc. from landowners; Local, State or Central government authorities for the extraction, reconstitution and transportation of such materials to the relevant worksite.

2.14 ALIGNMENT & YARD PLANS ETC

2.14.1 The alignment plans, yard plans, building plans and power supply schemes and SCADA layouts listed in Bid Document Part 2, Section VII-3: Drawings and Documents are for reference purpose only.

2.14.2 The Contractor shall review, verify and revalidate all relevant factors which could have an impact on the Design and construction / Installation of 2X25 kV, 50 Hz, AC, Traction Electrification and associated works including but not limited to the topography, subsurface conditions, ground water levels, Temporary Works, dewatering, drainage, climatic conditions, the availability or lack of access, working space, storage, accommodation, restrictions imposed by the existing Indian Railways Tracks, the proximity of adjoining structures and roads, the local regulations regarding the obstruction of public highways and any other limitations imposed by the site and its surroundings, for the satisfactory completion of Works meeting with performance requirements in the stipulated time.

2.14.3 It will be presumed that Contractor has verified at his end and taken note of all effects of these constraints in his Design, construction / Installation operations to ensure on-time completion of the Works.

2.14.4 No claim by the Contractor on the grounds of lack of foresight or knowledge of the site conditions or any unknown parameters shall be considered.

2.15 UNITS OF MEASUREMENT

The Contract shall utilize the SI system of units.

2.16 CLIMATIC CONDITIONS

2.16.1 General

(1) The project length, from Prithla – New Harsana Kalan section falls along the Tropic of Cancer. The design should consider the lowest and highest temperatures witnessed in the section.

a. During the summer months the temperature as high as 48^{o}C temperatures has been recorded in the section with a high level of humidity.

b. During the winter months the temperatures lowest of (-) 3^{o}C during night has been recorded in the section.

c. Torrential rains and high humidity accompany the monsoon are in late June to early September.

d. The Contractor's design should meet the requirement of the highest ambient temperature of 50^{o}C and lowest ambient temperature of (-) 5^{o}C.

2.16.2 The above information is indicative only. Notwithstanding the stipulation at (1) above, the contractor shall collect climatic data in respect of minimum & maximum temperatures, rain, flood levels, relative humidity, sun shine and wind velocity/pressure etc. from "India Meteorological Department publications" or other Civic Bodies and shall consider for designing any part/ component of the Permanent Works and in case the ambient temperature is beyond the range of 50^{0}C and (-) 5^{0}C, the Contractor shall ensure that due allowance is made for severe most local conditions in which Permanent Works are required to operate, for example, with restricted ventilation that may lead to higher local ambient temperatures, and any other factors that may affect the operating environment in any way.

2.16.3 The Contractor's attention is drawn to the more severe environmental conditions that may exist during the construction/ Installation period. The contractor shall take adequate measures to protect the Permanent Works against any deleterious effects of such conditions during the time between installation and final completion of the Project. The Contractor shall be deemed to have taken into account all weather conditions arising from any cause whatsoever, including river flooding, excessive rainfall, salinity, temperature, humidity, high winds, lightning, or any other weather conditions as per IS 13736 (all parts) and as per the application duty requirement.

2.16.4 Without limiting its liabilities under the Contract, the Contractor shall take all necessary precautions to protect the Works and Contractor's Equipment against the effects of weather, provided however Contractor shall inform the Engineer in such circumstances which lead to stoppage of works.

2.16.5 Classification of Equipment Environment

(1) Table below gives the different classifications of equipment environment to be encountered. The locations at which equipment may be installed have been divided into five environmental classes as mentioned below.

CLASS	LOCATION of EQUIPMENT
A	Air Conditioned Offices and Equipment Rooms. Air-conditioning failure of less than 2 hours duration at a time is permissible.
CLASS	**LOCATION of EQUIPMENT**
B1	Equipment Rooms with air-conditioning with possibility of failure of air-conditioning for a duration of 2 hours or more at a time.
B2	Equipment Rooms without air-conditioning where adequate ventilation may or may not be available.
C	Buried underground or installed in manholes.
D	Outdoors – Cabinets or Containers protected from direct sunlight without any ventilation.

(2) All equipment shall be designed and tested in accordance with the given figures in the Employer's Requirement. All designs for equipment shall work within the enclosures proposed with the specified environment outside the enclosure. The following are the minimum design requirements for equipment to be installed in each class of environment. Where any class does not have a value for a parameter the most extreme value quoted for the lesser class environments should be used. For any equipment that is proposed to be installed in more than one environmental clause, the design shall take into account the most severe environmental class conditions.

(a) Requirements for Class A	
Minimum Temperature	5°C
Ambient Temperature	29°C
Maximum Temperature	35°C
Relative Humidity	Minimum 0%, Nominal 65%, Maximum 95% (Non Condensing)
Electrical Noise	High Frequency to 1MHz. 1kV damped to 50% after 6 cycles. Radio Frequency field strength 10 V/m, UHF & VHF bands.

(b) Requirements for Class B	
Minimum Temperature	(-) 2.5°C (B1) and (B2)
Ambient Temperature	30°C (B1) and 50°C (B2)
Maximum Temperature	45°C (B1) and 55°C (B2)
Relative Humidity	Nominal 70%, Maximum 100% (Non condensing)

Air Quality	Polluted and dusty - SO_2:80-120mg/m3 Suspended Particulate Matter: 360-540mg/m3
Electrical Noise	Impulse 1kV, 1.2/50 rise/decay, 500Σ source impedance, 0.5J source energy.
Radio & High Frequency	as Class A.

(c) Requirements for Class C	
Minimum Temperature	(-) 2.5°C
Ambient Temperature	46°C
Maximum Temperature	60°C
Relative Humidity	Nominal 70%, Maximum 100% (Non condensing)
Electrical Noise	Impulse 5kV, otherwise as Class B

(d) Requirements for Class D	
Guaranteed Temperature Range	0°C to 55°C
Operational Temperature Range	(-) 5°C to 60°C

(End of Chapter 2)

CHAPTER 3 - PROJECT PLANNING & MANAGEMENT

3.1 GENERAL

3.1.1 In order to ensure compliance with the Requirement of Contract and satisfactory Programed execution of the works within specified targets, and quality in design, manufacturing and execution of work, a series of Management Plans shall be developed.

3.1.2 The Plans and Documents shall be coordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc. and shall show how these combine together to assure that the Works truly meet the requirements of the Specification in respect of the mentioned subjects.

3.1.3 Unless otherwise stated in the PS, all plans and documents shall be submitted as detailed below :

(1) As required in accordance with the Works Program;

(2) whenever the development of the Contractor's designs or planning allows the plan to be developed further;

(3) in response to comments made by the Employer's Personnel/Engineer

(4) whenever any change occurs that invalidates the information contained in the previously submitted and reviewed document, within 28 days of the occurrence of such change; and

(5) as requested by the Engineer from time to time

3.1.4 The following Management Plans shall be developed and submitted by the Contractor for the Engineer's review.

Sr.	Management Plan/ Submission	Submission
1	**Project Management Plan**	42 days
2	**Mobilization Plan / Project Organization Plan**	28 days
3	**Document Management Plan**	28 days
4	**Design Management Plan**	28 days
5	**Design Submission Plan**	28 days
6	**Simulation Study Plan**	56 days
7	**Interface Management Plan**	42 days
8	**System Assurance Plan**	56 days
9	**Quality Assurance and Management Plan**	56 days
10	**Reliability, Availability, Maintainability and Safety (RAMS) plan.**	90 days
11	**EMC/EMI Management Plan**	42 days
12	**Software Quality and Assurance Plan**	42 days
13	**Fire Safety Plan**	42 days
14	**Verifications, Validation and Demonstration Plan.**	90 days
15	**Procurement Management & Manufacturing Plan**	56 days
16	**Factory Acceptance Test Plan**	180 days

17	**Installation Plan**	90 days
18	**Site Management Plan**	42 days
19	**Site Safety Plan**	56 days
20	**Health & Environment Plan**	56 days
21	**Testing & Commissioning Management Plan including Trials and Integrated testing & commissioning**	180 days
22	**Permits and Approvals plan**	90 days prior to date of Taking over of Completed works.
23	**Training Plan**	90 days. Prior to the commencement of the First Training Session of the course
24	**Operation & Maintenance Plan and Spares Management**	180 days prior to date of Taking over of Completed works.
25	**Defect Liability & Notification Plan**	180 days prior to date of Taking over of Completed works.

3.1.5 These plans shall be further developed / modified / magnified in accordance with the procedure described in this General Specification during the course of the Project as required.

3.1.6 The respective Plans shall be submitted which shall have received 'No Objection' from Engineer who shall have the right to request the Contractor to make amendments as deemed necessary.

3.2 PROJECT MANAGEMENT PLAN

3.2.1 The overall management of the Works shall be the Contractor's responsibility. The organization of the resources for the design, procurement, manufacture, delivery, installation, testing and commissioning, and setting to work is to be clearly defined & developed into a Project Management Plan. Each section of this plan shall fully describe the Contractor's understanding of the Works and management skills and structure required to achieve the same.

3.2.2 The Contractor shall nominate suitably qualified and experienced English-speaking engineers from his staff to be Project Manager, Deputy Project Manager(s), Senior Engineers and other Key personnel as specified in Part-2. The nominee(s) shall be subject to acceptance of the Engineer, who shall have the right to demand his/their replacement at any time after the work commences, should the Engineer consider this to be in the best interest of the Project.

3.2.3 The Project Manager(s) shall be mobilized on full time basis for execution of work at site, within 28 days from the Commencement Date and shall continue up to the end of Defects Notification Period. The contractor shall establish & maintain the required Project management / Site office(s) at location(s) as approved by the Engineer and shall be retained to meet the contract Obligations until the completion of the Defect Notification Period.

3.2.4 The Contractor shall nominate dedicated senior engineers to co-ordinate activities of :

(1) The design offices responsible for designing;

(2) Procurement and manufacturing works;

(3) Construction / Installation;

(4) Testing & Commissioning;

(5) Other activities as required

3.2.5 The Project management plan shall define the Contractor's management structure for the execution of the Works and for the control of the quality of the Works and shall, without limitation, identify and set out:

(1) The procedure for audit;

(2) The procedures for the control of receipt and issue of all Works related correspondence so as to ensure traceability;

(3) The procedures for filing system to be implemented to maintain the Contractor's records during the course of the work. The filing systems used by the Contractor and sub-contractors of any tier shall be compatible;

(4) The procedures for the identification, production, verification, internal approval, review (when required) by the Engineer, distribution, implementation and recording of changes to all drawings, reports and specifications;

(5) The procedures for the evaluation, selection, engagement and monitoring of sub-contractors / suppliers together with the means of application of quality assurance to their work including audit and acceptance;

(6) The procedure for the regular review and revision of each type of quality plan and its supplemental individual specific quality plans to ensure their continuing suitability and effectiveness, in addition to the method to be used for revision and issue of revised documentation;

(7) The procedures for the control, calibration and maintenance of inspection, testing and measuring equipment;

(8) The procedures for the selection, indexing, disposition and maintenance of project records for storage in the archives. A list of items to be archived including their periods of retention shall be submitted for review by the Engineer;

(9) The procedures for identifying training needs and for the provision of training of all personnel performing activities affecting quality; and

(10) The procedures for the control of non-conformity.

3.2.6 The Project Management Plan submitted by the Contractor shall be reviewed by the Engineer, who will have the right to seek amendments as deemed necessary by the Engineer

3.2.7 Contractor's Personnel

(1) The Contractor shall provide all necessary supervision during the execution of the Works as long as the Engineer considers necessary for the proper fulfilment of the Contractor's obligations under the Contract.

(2) The Contractor shall ensure that he is at all times represented on the Site by a competent and authorised English/Hindi speaking Personnel who shall be deemed

to have been reviewed without objection by the Engineer, in writing within 14 days from the service of a notice upon the Engineer by the Contractor for the appointment of such Personnel. Such Contractor's personnel shall be constantly on the Site and shall give his full time to the superintendence of the Works.

(3) The Engineer shall have the authority to withdraw his notice of no objection to the Contractor's Personnel at any time. If such notice of no objection is withdrawn, the Contractor shall remove the Contractor's Personnel from the Site forthwith and shall not thereafter employ him again on the Site in any capacity and shall forthwith replace him by another competent English/Hindi speaking Contractor's Personnel as 'reviewed without objection' by the Engineer.

(4) Such authorised Contractor's Personnel shall receive on behalf of the Contractor directions and instructions from the Engineer.

(5) The following particulars of the proposed Contractor's Personnel shall be submitted to the Engineer for review:-

(i) name;

(ii) copy of Identity Card;

(iii) details of qualifications, including copies of certificates; and

(iv) details of previous experience.

(6) The particulars of the Contractor's Personnel shall be submitted 28 days before the agreed 'scheduled start' of that part of the Works, except in the case of a replacement of Contractor's Personnel, in which case, the said particulars shall be submitted forthwith.

3.3 MOBILIZATION PLAN

3.3.1 The Contractor shall within 28 days from the Commencement Date submit a mobilization Plan for the Engineer's review.

3.3.2 The Mobilization Plan shall include but not be limited to Setting up of Design Office, Site office, mobilization of Contractor's Key and support personnel, Procurement of facilities, Information required by the Contractor and deliverables to be submitted.

3.3.3 Manpower forecasts shall be prepared in the form of a series of graphic displays based on the Works Program resource-loading. The output shall display the number of man-days of effort, for each month over the life of the Project on both 'early start' and 'late start' basis.

3.3.4 Within 7 Days of receiving the Letter of Acceptance (LOA) of the work, Contractor shall set up the required communication facilities i.e. office Telephone, fax and documentation facility immediately.

3.3.5 Within 15 days of receiving the LOA of the work, the Contractor shall issue a communication matrix identifying the Project Manager and the other key personnel with their roles and responsibilities and their communication telephone, mobile, fax and email addresses and shall keep it updated throughout the project.

3.4 DOCUMENT MANAGEMENT PLAN

The contractor shall establish a Document Management System as detailed in Chapter-5: Document Management of this GS. Document Management Plan shall incorporate the

Document Control Procedures such as:

a. Document Format;

b. Document numbering system;

c. Document release / version control;

d. Obsolete/ superseded Document withdraw system;

e. Number of copies.

3.5 DESIGN MANAGEMENT PLAN

3.5.1 Design shall be undertaken to ensure a smooth flow of information for review by the Engineer. Submissions shall be strictly in accordance with the Design Submissions Program**.**

3.5.2 The Contractor shall perform his designs for the Works and prepare a design plan for his design work in accordance with the following design stages. The Contractor shall submit to the Engineer for his review, relevant design information as identified under each stage:

a. Preliminary Design along with Performance parameters and design verification checklists, design Manual;

b. Detailed Design;

c. Construction / Installation Design & drawings;

d. As Built Documents.

3.5.3 The Contractor shall submit a Design Management Plan detailing the design process and describing:

a. The "Design Input" for the project;

b. The organization chart for the design team;

c. The process for integration of all the systems;

d. The process for internal design review and signing of drawings and design documentation (by officials with name i.e. prepared by, checked by and issued by) prior to submission for review by the Engineer;

e. The design Submission Program;

f. The process for design change control.

3.6 DESIGN SUBMISSION PLAN

3.6.1 The objective of the design submission plan is to ensure that the proposed resulting works comply with the Employer's Requirements and the Standards and Specification, are capable of being produced consistently to exacting quality standards, achieve low life cycle costs and can be operated with high reliability and safety to the satisfaction of the Engineer.

3.6.2 The design submissions include design calculations, design reports and design drawings.

3.6.3 In the event that a statutory body (e.g. Government of India Ministry of Railways, RDSO, Commissioner of Railway Safety, etc.), Independent Engineer, independent RAMS assessor or independent safety assessor requires design information in a particular format or any other additional information, it shall be incumbent upon the Contractor to provide the same, as directed by the Engineer.

3.7 SIMULATION STUDY PLAN

3.7.1 The Contractor shall identify the simulation study requirements as specified in Particular Specification and submit a Simulation Study Plan identifying:

(1) the Activities and deliverables of simulation study;

(2) Identification of the proven simulation agency;

(3) Approval of the Engineer / Employer’s Personnel and engagement thereof of the Simulating Agency;

(4) Submission of Input Data Reports;

(5) Review of the Input Data Report by the Engineer;

(6) Incorporation of the observations of the Engineer;

(7) Producing Simulation and Simulation results for various options;

(8) Review of The Simulation Results by the Engineer/ Employer’s Personnel;

(9) Incorporation of the observations of Engineer/ Employer’s Personnel on Simulation Results;

(10) Conducting revised Simulation and Producing Simulation results for various options;

(11) The Simulation Results shall conform and validated to Standards EN 50119, EN50317, EN50318, EN50329, EN50388, EN50367, EN50641, EN50163, EN50122-1, EN50124-1 , EN50121 (all Parts), IEEE80:2013, IEC 60909 and other standards as specified in Part 2-Employer’s requirement.

3.7.2 The simulation study may involve a number of iterations to optimize the Solution.

3.7.3 Simulation study shall suggest a value added optimized solution with reasoning.

3.7.4 The Scope of Simulation Study is included in Particular Specification.

3.8 INTERFACE MANAGEMENT PLAN

3.8.1 The Contractor shall interface and liaise with Other Contractors in accordance with the Employer’s Requirements, Chapter-10 – Interface Management Plan of this GS and in relevant chapter of Part – 2, section VII – – 2 : Particular specifications.

3.8.2 The Contractor shall develop and submit to the Engineer, an Interface Management Plan, which is mutually acceptable to both the Contractors and the Other Contractors. The Interface Management Plan shall:

(1) identify the sub-systems as well as the civil works and facilities with interfacing requirements;

(2) define the authority and responsibility of the Contractor's and Other Contractors' (and any relevant sub-contractors') staff involved in interface management and development;

(3) Identify the information to be exchanged, precise division of responsibility between the Contractor and Other Contractors and integrated tests to be performed at each phase of the Contractor's and Other Contractors’ works;

(4) Address the Works Program of the Contract to meet dates of activities of each Contractor and highlight any program risks requiring attention of the Employer.

3.8.3 The Engineer shall review the Contractor's initial Interface Management Plan and shall have the right to require the Contractor to make amendments as deemed necessary by the Engineer. The Contractor shall amend the initial Interface Management Plan based on the comments received from the Engineer and submit the final Interface Management Plan and the Engineer shall issue an Advice of No Objection to such Interface Management Plan.

3.8.4 The Contractor shall be responsible for detailed co-ordination of his design, manufacturing, construction/installation, testing and commissioning activities and will take the lead for System Works in the management of the coordination process with IR, interfacing contractors, utility agencies, statutory authorities, private service providers, consultants and other contractors whether or not specifically mentioned in the contract that may be working on or adjacent to the site for the purpose of the Project.

3.8.5 System Work Contractor, Electrical shall plan his interfacing requirements accordingly.

3.9 SYSTEM ASSURANCE PLAN

The Contractor shall submit, the System Assurance Plan for approval of the Engineer as described in the RAMS Chapter-12 of this GS.

3.10 QUALITY ASSURANCE AND MANAGEMENT PLAN

The Contractor shall submit the Quality assurance and Management for approval of the Engineer as described in Chapter -11 of this GS.

3.11 RELIABILITY, AVAILABILITY, MAINTAINABILITY & SAFETY (RAMS) PLAN.

3.11.1 The Contractor shall submit a RAMS Plan for approval of the Engineer as described in the RAMS chapter-12 of this GS and relevant chapter in PS.

3.11.2 The Contractor shall describe procedures required to perform the specific tasks necessary to achieve RAMS requirements in this plan including the RAMS demonstration Plan.

3.12 EMC/EMI MANAGEMENT PLAN

3.12.1 The Contractor shall prepare and submit for review by the Engineer, an EMC Plan in accordance with the Employer's Requirements. The Contractor shall describe procedures required to perform the specific tasks necessary to achieve EMC requirements.

3.12.2 EMC/EMI Management Plan should be based on a top-down approach defining the EMI, EMC philosophy, Assessment & Control activities, means of control during design processes and implementation and EMC submissions to be supplied to demonstrate compliance with Employer's Requirements: General Specification and Particular Specification. The EMC/EMI Management Plan shall identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the Employer's Personnel / the Engineer for review. The EMC Management Plan shall also include a Program for the dates for EMC submissions.

3.12.3 The EMC/EMI Management Plan shall include an initial list of design documentation, test specifications and test reports with a single paragraph description of each document to indicate compliance with the Specification.

3.12.4 The EMC/EMI Management Plan shall include a definition and description of the process and methods used for Verification and Validation that the Works will achieve the required EMC parameters in all respects.

3.12.5 The Contractor shall assess and control the levels of interference emissions and susceptibility of all equipment which are to be designed, manufactured, supplied and installed by the Contractor and its sub-contractors and suppliers.

3.12.6 The Contractor shall designate a person as point of contact to deal with EMC matters. Details of the nominated person and any subsequent change of the nominated person shall be subject to review by the Employer's Personnel/ The engineer.

3.12.7 The Contractor shall liaise and co-ordinate with all Other Contractors in the exchange of EMC data and related equipment performance characteristics and advise the Engineer when any such information is requested from any Other Contractor. A copy of all EMC related information exchange shall be sent to the Engineer for review.

3.12.8 The Contractor shall comply with the following EMC requirements:

(1) The Contractor shall ensure that all electrical and electronic apparatus is designed and constructed to operate without degradation of quality, performance or loss of function in the electromagnetic environment of the Project.

(2) The Contractor shall meet the requirements of the BS EN 50121 series of standards (Railway applications – Electromagnetic compatibility), 1996 edition, the UK's Electromagnetic Compatibility Regulation, the IEC 61000: Electromagnetic Compatibility or equivalent and other standards mentioned in the Employer's Requirements-Particular Specification. EMC considerations shall be incorporated in the Contractor's procedures for product safety and design Verification.

(3) The design shall ensure that any electromagnetic interference emissions introduced into the environment do not exceed the limits as prescribed in Standards. The Contractor shall ensure that electromagnetic compatibility (EMC) requirements are adequately complied. Any shortcomings shall be made known to the Engineer immediately and recommendations for corrective action formulated.

(4) In respect of the design documentation, the Contractor shall demonstrate by theoretical analysis that the design of the electrical and electronic systems is fully compliant with the EMC requirements identified. The Contractor shall state clearly in the documentation all the assumptions made and parameters used in the analysis.

(5) The Contractor shall detail the methodology, verify and validate any simulation models used in support of the analysis. The Contractor shall prepare and submit to the Engineer for review reports of the Verification and Validation of the models.

(6) The Contractor shall submit documentation/ evidence showing how system safety and reliability is not affected with achieved EMC. It shall include Failure Modes, system failures, and the effect of human intervention and how equipment EMC thresholds have been set in order to keep them above worst

case interference levels, and how equipment tolerances and other characteristics in the Specification have been allowed for in designing the system.

(7) The Engineer may conduct an independent EMC audit for both the system and its component parts and shall therefore require access to all the relevant design and production information. The Contractor shall supply sufficient documentation and analysis in a form reviewed by the Engineer.

(8) EMC type testing as per standards shall be carried out on all equipment identified in the design stage, which require attention regarding EMC.

(9) The Employer's Personnel/ the Engineer may request at his discretion, attendance at the manufacturing factory prior to delivery to assist in providing confidence that the EMC requirements will be met. However, this will not give design acceptance that can only be given after successful completion of the System Acceptance Tests.

(10) The Employer's Personnel/ the Engineer may request that tests be carried out to simulate the Failure Mode of any critical hardware/software component that is considered to have a significantly detrimental effect.

(11) The Contractor shall implement corrective actions to rectify any EMC problems identified during design, on-Site testing and when the whole system is in operational service.

3.12.9 The Contractor must be fully aware of the EMC requirements and any modifications to systems and equipment carried out by the Contractor during the Defect Notification Period shall not cause the immunity or emission levels of the installed system and equipment to exceed such values. Detailed EMC documentation on all modifications carried out shall be submitted to the Engineers for review. Modification work shall not commence until the respective submission has been reviewed without objection by the Engineer.

3.13 SOFTWARE QUALITY AND ASSURANCE PLAN

Where software is design Deliverable, the Contractor shall submit the Software Quality Assurance Plan for approval of the Engineer as described in RAMS Chapter-12 of this GS. The Software quality Assurance plan shall address all elements of the design and development of the software required as part of the works.

3.14 FIRE SAFETY PLAN

The contractor shall conduct a Risk and hazards study to identify the fire hazards for each system / sub-system /components. Such study shall include but not be limited to l Power supply installations and short circuit faults on OHE system assess the fire load, the Fire size (height & volume and gradients) and find out the Mitigation measures at Substations and Switching Stations. The Contractor shall develop a Fire safety Plan in compliance of NFPA – 130.

3.15 VERIFICATION, VALIDATION AND DEMONSTRATION (VVD) PLAN

3.15.1 The contractor shall prepare a Verification, Validation and Demonstration plan to validate and demonstrate system performance and reliability.

3.15.2 The Design Verification and Validation (DVV) plan, supplementary to design

Management plan shall be prepared by the Contractor in order that design Verification and validation activities are properly directed. The plan shall address, but not be limited to, the following:-

(1) the objectives of each Verification phase and each Validation phase;

(2) defined input and output criteria for each development phase;

(3) identification of types and detailed methods of test, Verification and Validation activities to be carried out;

(4) detailed planning of Verification and Validation activities to be carried out, including schedules, resources and approval authorities;

(5) selection and utilisation of the test equipment, and their test environmental conditions; and

(6) criteria on which the Verification or Validation is judged to be acceptable. These criteria shall be traceable to the design and performance requirements.

3.15.3 The Performance Deliverables for each system/ subsystem/ component as applicable and as identified in Particular specification shall be got verified and validated by the Contractor. The Contractor shall prepare a Design Verification Table (DVT) that identifies the contractor's proposed methodology for demonstrating compliance.

3.15.4 The DVT shall be supplied to the Engineer for his review and shall be monitored throughout the design and construction of the works. Changes, if any, to the DVT, must be submitted to the Engineer for approval before implementation.

3.15.5 The DVT shall identify the proposed Verification and Validation process (es) for each specification requirement and the acceptance criteria for achieving the requirement. The DVT does not relieve the contractor of any other requirements of the Specifications in relation to design review, Verification, Validation, conformance or planning.

3.15.6 For each item in the DVT, the Verification and Validation methods to be used shall be listed by the Contractor. The methods used shall be reviewed by the Engineer.

3.15.7 Subject to review without objection by the Engineer for each application, the Verification and Validation methods listed below are acceptable if implemented (whether singly or in combination):

(1) Similarity – equipment and requirement are identical to those successfully applied on other projects.

(2) Historical – requirement has been met by numerous pervious design.

(3) Calculations and Drawings – for review.

(4) Design Review – either scheduled or specifically targeted.

(5) Development Test – performance testing on equipment or material under development.

(6) Type Test – performance testing of the as-built component, assembly or system.

(7) Routine Test – test every component, assembly or system.

(8) First Article Inspection (FAI) – acceptances of the exact look and fit of equipment.

(9) Inspection – formal inspection of the finished item.

(10) In Service – for service demonstration requirements only.

3.15.8 After each Verification or Validation activity, a Verification Report shall be produced including, as a minimum, the following:

(1) The Verification or Validation results stating whether the objectives and criteria of the Design Verification and Validation Plan have been met; and

(2) The reasons for failure if there is a failure, and proposal for remedial actions.

3.15.9 The Results of Verifications and Validations shall be demonstrated to the Engineer with evidence of records and tests.

3.15.10 Verification and Validation (V&V) shall include the demonstrations as required for the RAMS.

3.16 PROCUREMENT MANAGEMENT & MANUFACTURING PLAN

3.16.1 The Contractor shall prepare & submit for review by the Engineer, a Procurement Management & Manufacturing Plan comprising of the details on Procurement, Manufacturing and Delivery Plan in respect of all items and goods. Separate parts of the plan shall also be prepared by the Contractor, his suppliers and subcontractors for their off-site activities. Each plan shall identify the scope of work to be applied. In relation to such scope of work, it shall, without limitation, define:

(1) the organisation of the Contractor's personnel directly responsible for the day-to-day management of the manufacturing activity on or off the Site;

(2) the specific allocations of responsibility and authority given to identified personnel for the day-to-day management of the work with particular reference to the supervision, inspection and testing of the work;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) a full list of manufacturing method statements for major components, equipment and/or systems to identify the specific methods of manufacture;

(5) The format of the Material Control Schedule to monitor and control the production, manufacturing and delivery, for the Contractor, sub-contractors of any tier, suppliers and sub-suppliers;

(6) the list of procedures and work instructions to manage and control the quality of work during purchasing, manufacturing and delivery, including without limitation:

a. the purchasing of items and goods and ensuring they comply with the requirements of the Specification, including (without limit) purchasing documentation and specific Verification arrangements for Contractor/the Engineer, inspection of material or manufactured product prior to release for use;

b. the manufacturing process so as to ensure compliance with the design;

c. the manufacturing process so as to ensure clear identification and traceability of material and manufactured parts;

d. the inspection & testing of inward materials/in process & final product to ensure specified requirements for the material and/or manufactured product are met;

e. the identification of the inspection and test status of all material and manufactured products during all stages of the manufacturing process toensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;

f. review and disposal of non-conforming material or product so as to avoid unintended use;

e the assessment and disposal of non-conforming material and manufactured product and approval for reworking or rejection as scrap;

f the identification of preventive action so as to prevent recurrence of similar non-conformance; and

g the handling, storage, packaging, preservation & delivery of manufactured product.

3.16.2 The Contractor shall prepare and submit the inspection and testing plans to manage and control any test and inspection activities.

3.16.3 The Contractor shall propose a structured set of inspection hold points. The hold points shall be structured such that a formal hold point is allowed for each significant element of the manufacturing process. At each hold point, the Employer's Personnel/ the Engineer shall hold a formal inspection or advise that the inspection has been waived.

3.16.4 Once the inspection and any required remedial actions are completed to the satisfaction of the Engineer, the Engineer may give a notice of no objection to the results of Inspection as jointly witnessed. The Engineer will not withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has been successfully completed.

3.16.5 The Material delivery plan shall cover each and every part of the delivery of all items and goods from the manufacturing premises to the Site. The delivery plan shall cover all lifting and handling activities and the steps to be taken to protect all items and goods from damage during each segment of the journey. The arrangements for customs clearances, inspections, highways permits etc. shall also be fully described.

3.16.6 The Material control schedule shall be automated, and shall detail the following information for each permanent major and minor material and significant component. The format of such a schedule shall include:

a. Activity reference

b. Name, description of item/ activity;

c. Supplier/sub-supplier details;

d. Time required for manufacture/ construction;

e. Drawing information (where appropriate), title, drawing status, submission dates, shop drawings/ fabrication drawing preparation, etc.;

f. Manufacturing process, manufacturing of test pieces, trial production, the Engineer inspection, monthly production of components and monthly supply of components;

g. Assembly process, erection and assembly sequences (particularly for the first pieces) prior to shipment, test assemblies, monthly assembly requirement the Engineer inspection, testing of assemblies; and

h. Purchase order date; and

i. Transportation process, quality release from factory, factory storage, transport to dock, shipment.

3.16.7 The Schedule shall also be updated for:

a. Factory Acceptance Test (FAT) Date

b. Scheduled Shipping Date.

c. Scheduled Job Site Arrival Date.

d. Shipping Method Air/Ocean Classified/Unclassified.

e. Actual Shipping Date.

f. Actual Arrival date.

g. Quantity Actually Received.

3.16.8 The schedule shall tie materials tracking to the respective work activity.

3.16.9 The Contractor shall continuously update this schedule and report upon the status of each item as part of the Contractor's regular progress reporting. From this base data, the Contractor shall prepare an exception report detailing all components that are in delay. This report shall be annotated with the reason for the delay and shall indicate what action the Contractor is taking to recover the lost time.

3.16.10 Manufacturing Submissions

The Contractor shall identify the specific methods of manufacture for major components, equipment and systems in the manufacturing method statements and develop those method statements to a degree of sufficient detail to be reviewed by the Engineer. All manufacturing method statements shall be submitted for review by the Engineer 56 days prior to the commencement of the respective manufacturing activities.

The Contractor shall prepare and maintain a full list of all the manufacturing method statements required for the Contract with submission status and review status, and shall submit to the Engineer upon request. The manufacturing method statement shall include, but not be limited to, the following:

a. the particulars of the materials to be incorporated into the items;

b. the manufacturing process flowcharts in compliance with drawings and specification;

c. the identification or referencing requirements for traceability of the manufacturing products;

d. the identification of inspection and test check points and status of materials and final manufactured products; and

e. The handling, storage, packing, preservation and delivery of the manufacturing products.

3.17 FACTORY ACCEPTANCE TEST PLAN

3.17.1 The Contractor shall prepare and submit for review by the Engineer the Contractor's Factory Acceptance Test Plan detailing and explaining how the Contractor will plan, perform, and document all inspections and tests that will be conducted to verify and validate the Works prior to delivery to the Site. The plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

3.17.2 The plan shall contain but not be limited to the following topics:

(1) The Contractor's strategy for inspection and Factory Acceptance Tests of all constituent parts of the Works and how this relates to the sequence of delivery

and Procurement Management & Manufacturing Plan;

(2) The sequencing and interrelationships of the inspections and tests including all Quality Hold Points and Quality Control Points;

(3) The type and extent of inspection and Factory Acceptance Tests to be undertaken and the parts of the Works to be proven by that testing;

(4) The objective of each inspection or test, what particular design and operating criteria the test or inspection will prove and how the success of the test or inspection will be demonstrated or measured;

(5) Organisation Chart of test team and CV of key personnel in inspection;

(6) The plan for the production and submission of the inspection and test procedures to the Engineer for review including the submission of the inspection and test reports and records; and

(7) Type Tests/Routine Tests/First Article Inspections and any other tests constituting the Factory Acceptance Tests.

3.17.3 This plan shall clearly demonstrate the logic of all related processes the logical dependencies between the individual tests of the Works, and shall also show the interfaces and dependencies with the Contractor's delivery program. The Factory acceptance Tests shall be carried out in OEM's Premises/ factory / Manufacturing place.

3.17.4 Factory acceptance Tests shall include Type/Routine/ acceptance/ special Tests at Original Equipment Manufacturer (OEM) factory or the Accredited Test lab / test house as approved by the Engineer". Routine tests shall include tests such as visual inspection, dimension check, electrical conductivity check, insulation check, calibration, mechanical and hydraulic tests and any other compliance tests etc. as per specification. Type tests shall be performed on a sample of the complete equipment of each type and rating etc. based on SOGP and agreed standards or specification. The FAT stage may also include some integration tests at the manufacturer's factory, which are performed to test the integration of the components that make equipment. Each software system (such as the SCADA system) shall be tested to simulate inputs and outputs including integration testing as possible, thereby reducing the overall integration risks to equipment at later stages. Each software FAT should take place in an environment as close as possible to the operational environment or suitably de-rated for application duty requirement.

3.17.5 The FAT Plan shall include a comprehensive list of the tests, Tests to be witnessed by representatives of various parties i.e. the Contractors' representatives, the Engineer or his representative, the duration of the test, Tentative dates, and minimum of 28 days prior notice period to all representatives to witness the test.

3.17.6 The FAT Plan shall include details of inspection, testing and witnessing of the Contractor's and subcontractor's procurement and manufacturing activities at OEM's Factory. As a minimum, it shall include:

a. First Article Inspection;

b. Quality Hold Points;

c. Type Tests; and

d. Routine tests.

3.17.7 The Contractor shall arrange for all equipment and systems manufactured for incorporation into the Permanent Works to undergo a Factory Acceptance Test (FAT) before shipment from the place of manufacture.

3.17.8 The Contractor shall be responsible for re-inspecting and re-testing any failed inspection and Factory Acceptance Test including regression testing on previously passed items.

3.17.9 Inspections and tests that are to be witnessed by the Employer's Personnel /the Engineer shall be sensibly grouped and scheduled so that as many inspections and tests as possible may be witnessed during a single visit.

3.17.10 The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Employer's Personnel/ the Engineer. If the Employer's Personnel /the Engineer has witnessed the inspection or test, he may countersign the inspection or test (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein. If the Employer's Personnel /the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. In case the results of the inspection or test do not meet the requirements of the Specification, the Employer/ the Employer's Personnel/ the Engineer may call for a re-inspection or re-test.

3.17.11 For standard equipment which is serial or bulk manufactured, manufacturer's type test certificates (or equivalent) may be acceptable, subject to review by the Engineer.

3.17.12 Test equipment and instrumentation shall be subject to approved calibration tests within a properly controlled calibration scheme, and signed calibration certificates shall be supplied to the Engineer in duplicate. Such calibration checks shall be undertaken prior to testing and, if required by the Employer's Personnel/ the Engineer, shall be repeated afterwards.

3.17.13 Materials and equipment shall not be released for shipment until all applicable inspections and tests including Factory Acceptance Tests have been satisfactorily completed.

3.18 INSTALLATION PLAN

3.18.1 The Contractor shall prepare and submit Installation Plan for the Engineer's approval.

3.18.2 The Plan shall be configured as a family of "stand-alone" plans and associated documents for each System and subsystems as required.

3.18.3 The plans shall be coordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc. and shall show how these combine together to assure that the Works truly meet the requirements of the Specification in respect of the subjects listed.

3.18.4 The Contractor shall prepare plans for the construction & installation activities on and off the site, and shall ensure that these are properly related to the subsequent testing and commissioning activity. Separate parts of the plan shall be prepared for other contractor(s) or sub-contractor(s) off-site activities.

3.18.5 Where all or part of the works is within the HORC Protection Zone, the contractor shall follow the guide lines issued by the Employer's appropriate authority. The Contractor shall submit to the Engineer for review, his construction method statement and detailed design of any Temporary Works proposed to be erected within this zone adjacent to IR/DFCCIL properties.

3.18.6 The plan shall, without limitation, describe:

(1) The organisation of the Contractor's staff directly responsible for the day-to-day management of the activity on or off the Site;

(2) The specific allocations of responsibility and authority given to identified personnel for the day-to-day management of the Works with particular reference to the supervision, inspection and testing of the Works;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) the specific methods of construction and installation to identify any relevant method statements and develop those method statements to a sufficient degree of detail reviewed by the Engineer;

(5) A detailed method statement which shall include but not be limited to:

a. Description of main operations and sub-operations;

b. Sequence of sub-operations;

c. Quantities of the work and production rates to be achieved;

d. Resources to be employed; and

e. Quality checks to be carried out, supervision being exercised and safety precautions to be employed;

(6) the list of procedures and work instructions to manage and control the quality of construction and installation works, including without limitation:

a. The inspection and testing activities of incoming materials, in process and final product so as to ensure specified requirements for the material and/or product are met;

b. The procurement of materials and ensuring they comply with the requirements of the Specification, including purchasing documentation and specific Verification arrangements for Contractor/Employer's Personnel / the Engineer inspection of material or manufactured product prior to release for use/installation;

c. The construction processes including Temporary Works so as to ensure compliance with drawings and Specification. In addition, any software to be used in the construction, installation and commissioning process shall be identified and details of the Verification and Validation processes for the software application shall be given;

d. The construction and installation process so as to ensure clear identification and traceability of material and manufactured product;

e. The identification of the inspection and test status of all material and manufactured products during all stages of the construction and installation process to ensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;

f. The assessment and disposition of non-conforming material and product and approval for reworking or rejection as scrap;

g. The identification of preventive action so as to prevent recurrence of similar non-conformance; and

h. The handling, storage, packaging, preservation and delivery of product; and

i. The security control of the Site and the works area for Contractor's accommodation, storage, car park and other works facilities, etc.

3.18.7 The following particulars shall be submitted to the Engineer for review within 28 days of the Commencement of any Construction activity at site:

(i) drawings showing the layout within the Site of the Engineer's and Contractor's accommodation, Project signboards, access roads and major facilities required;

(ii) Construction Reference Drawings, Shop drawings etc.

3.18.8 Drawings showing the location of stores, storage areas, work areas and other major facilities shall be submitted to the Engineer for review as early as possible, but in any case not later than 28 days before commencement of construction of the facilities.

3.19 SITE MANAGEMENT PLAN

3.19.1 The Contractor shall submit Site Management Plan describing access, security, material storage, handing over and taking over of assets as per the requirement:

3.19.2 Access to Site

The Contractor will be given access to the Site in accordance with the Contract. Contractor shall manage the execution within allocated Right of Way (ROW). The Contractor shall coordinate with CST contractors for the same.

3.20 SITE SAFETY PLAN

The Contractor shall establish and maintain various provisions of Site Safety Plan as detailed in Chapter-9:- Site Safety Plan of this GS.

(1) The Contractor shall submit, as part of his Safety Plan, a Site Management Plan, and also designate a Safety Officer who shall be a person properly qualified to ensure the safety at construction sites.

(2) The Contractor shall be fully responsible for the safety of the Works, his personnel, his sub-contractors' personnel, the public, and any persons directly or indirectly associated with the Works, or on or in the vicinity of the Site. The Contractor shall treat safety measures as high priorities in all his activities throughout the execution of the work.

(3) The Contractor shall submit to the Engineer, regular Site Safety Reports, and shall notify immediately the occurrence of an accident involving his staff or that of his sub-Contractors, or to any person within the area of the Site for which the Contractor is responsible.

3.21 HEALTH & ENVIRONMENT PLAN

3.21.1 The Contractor shall submit Health & Environmental Plan illustrating the intended means of compliance with the Employer's Safety, Health, and Environmental Requirements Manual. The Health and Environmental Plan shall contain sufficient information to demonstrate clearly the proposed method of achieving the environmental objectives with particular reference to Noise, Vibration, and EMC/EMI etc. The Contractor shall co-operate in any environmental audit conducted by HRIDC or the Engineer.

3.21.2 Environmental Plans shall include the Contractor's proposed means of complying with his obligations in regard to:

a. The Site Environment as found;

b. System Environment as described in the Specification;

c. policies, procedures, applicable regulations and mitigation measures

d. SHE Manual.

3.21.3 Where the Contractor is required to become involved with traffic or footpath management activities, Traffic Management submissions shall be made by the Contractor for Engineer's review 56 days before implementation proving all relevant details and implications.

3.22 TESTING & COMMISSIONING MANAGEMENT PLAN INCLUDING TRIALS AND INTEGRATED TESTING & COMMISSIONING

3.22.1 The Contractor shall submit a Testing and Commissioning Management Plan in accordance with this Employer's Requirements.

3.22.2 The plan shall describe the testing & commissioning strategy to be followed for the project at different stages and shall include but not limited to

(1) Factory Acceptance Test (FAT),

(2) Site Installation Test (SIT) / Standalone Testing,

(3) Site Acceptance Test (SAT),

(4) Integrated System Testing,

(5) Trial Runs & Commissioning.

3.23 TRAINING PLAN

The Contractor shall prepare and submit a Training Plan in a format and to a level of detail for review without objection by the Engineer. It shall be in accordance with Employer's Requirement.

3.24 OPERATION & MAINTENANCE PLAN

3.24.1 The Contractor shall prepare and submit for review by the Engineer an Operation & Maintenance Plan. The Plan shall include all the aspects related with the Monitoring, control & operation of the system / subsystem/ equipment and Maintenance thereof.

3.24.2 The Contractor shall develop an Operation & Maintenance Plan to suit staged commissioning of the system (if required) and to ensure the timely preparation of the Contractor's Operation and Maintenance Manuals and the 'As-Built' drawings in a format and to a level of detail reviewed without objection by the Engineer.

3.24.3 The Maintenance Plan & Maintenance Philosophy shall include the following:

(1) Proposed periodicity for each type of examination, inspection or overhaul,

(2) List of tasks to be carried out at each examination, inspection or overhaul,

(3) Man-hours required for each task,

(4) Replacement parts required at each examination, inspection or overhaul,

(5) Different levels of maintenance activities.

3.24.4 Spares Management Plan

The Contractor shall submit the Spares Management Plan not less than 180 days prior to the proposed date of issue of the Taking Over Certificate for the Works. As part of spares management plan the contractor shall:-

1. Submit for review by the Engineer a Spares Management Plan to furnish a priced manufacturer-recommended list of spare parts, necessary to support continuous operation of all such equipment for a minimum period of 24 months after the commencement of Revenue Operations.
2. Supply the spares, test equipment etc. as per the respective Particular Specifications. The Contractor may please note that all Spares needed for replacement during Defect Notification Period shall be resourced separately and shall not be allowed to use the mandatory spares as identified in PS during the construction or Defect Notification Period.

3.25 DEFECT LIABILITY MANAGEMENT PLAN

3.25.1 The Contractor shall submit for review by the Engineer a Defect Notification Plan to repair, replace and perform any remedial item upon the Works identified by the Engineer during the Defects Notification Period. The Contractor shall:

(1) Endeavour to complete all necessary work in a timely responsible manner;

(2) Not proceed with any remedial work without the consent of the Engineer;

(3) Submit a plan that details the methods and timing of any proposed work; and

(4) Update the plan monthly, showing progress of the work and the time to completion.

(End of Chapter 3)

CHAPTER 4 - PROJECT PROGRAM REQUIREMENT

4.1 GENERAL

4.1.1 The Contractor shall develop in detail, a logical method of executing the Works taking into account their complex nature and different phases and shall provide Project Implementation programs which reflect the detailed planning undertaken for implementation of the project.

4.1.2 The programs shall start with the Commencement Date of the Works as day one, are to be realistic, achievable and shall be accompanied by the detailed supporting Management Plans.

4.1.3 The Program activities shall be discrete items of work, which when combined and produces the definable elements, components, Milestones, Stages and Sections of the Works and clearly identify the completion obligations of the Contractor.

4.1.4 Milestones shall be an integral part of all Programs and all activities. Sequencing and interrelationships required to achieve each completion obligation shall be shown. Milestones shall not impose constraints that in a way affect the Program logic. Milestones shall not be introduced into any Program as constrained dates.

4.1.5 The critical path shall be clearly identified in the Program and fully described in the accompanying Program narrative.

4.1.6 Activity descriptions shall clearly convey the nature and scope of the Works. Programs shall take into account the activities of Precursor, concurrent, adjacent and follow on project contractors and any other activity that may affect the progress of the Works.

4.1.7 The Contractor shall also incorporate the Engineers requirement for additional activities, to further explain or subdivide complex or long duration tasks, without affecting completion dates.

4.1.8 The Contractor shall monitor its and its subcontractor's performance against programs to ensure its compliance with its obligations under the Contract. Monitoring of the Works shall include direct, daily monitoring of the progress of the Works and the preparation of return and computerized reports to be submitted to the Engineer. The reports shall include all necessary supporting data to apprise the Engineer of the status of the completion of the Works as described below:

4.1.9 The following Project Program submission shall be developed and submitted by contractor for the Engineer review within number of days (from the Date of Commencement) as specified below : -

Program Submission

S.No.	Programs	Submission
1.	Survey Plan and Program for Validation of Data Provided by Employer and Additional Surveys, if required by the Contractor.	56 Days
2.	Work Program	
2.a	Initial Version	56 days
2.b	Full Version	84 days
3.	Design Submission Program	56 Days
4.	Procurement Management and Manufacturing Program	90 Days
5.	Installation Program	180 Days

6.	Testing & Commissioning Program	180 Days
7.	Training Program	180 days

4.2 THE EXECUTION PHASES

The execution activity will include various phases of the implementation. The term Phases means a kind of stages of execution a system/ subsystem works or of a component or activity as generally would take place in a sequential manner. The next stage of activity can commence immediately after the completion of previous related activity. The Contractor will have generally following Execution Phases.

a. Design Phase,

b. Procurement, Manufacturing and Supply Phase,

c. Construction/Installation Phase,

d. Testing & Commissioning Phase and

e. Defect Notification Phase.

4.2.1 Design Phase

The contractor shall deploy the qualified team of the design Engineers and Experts as approved by the Employer Evidencing the experience of the design in relevant field and technology before commencement of Design Phase. The Design Phase shall be in 4 stages as detailed below:

a. Preliminary Design,

b. Detailed Design,

c. Construction / Installation Design & drawings and

d. As Built Documents.

4.2.2 Procurement, Manufacturing And Supply Phase

The Procurement, Manufacturing and Supply phase will constitute the following:

a. Manufacturing / Procurement, ,

b. Factory Acceptance Tests (FAT),

c. Delivery to the contractor's stores at site and

d. Storage at the site Stores including establishing the Material Procurement tracking, receipt and issue procedures.

4.2.3 Construction & Installation Phase

Construction & installation Phase will constitute of the following:

a. Site Management including access/ ROW, and preparation thereof;

b. Availability of Construction reference Drawings;

c. Installation preparatory works like Foundations, first fix, site safety and quality assurance procedures etc.;

d. Equipment installation and

e. Submission of verified and As Built Documents.

4.2.4 Testing And Commissioning Phase

Testing and commissioning phase will constitute of the following:

a. Testing and Commissioning of all subsystems;

b. Quality assurance and RAMS demonstrations;

c. Integrated Testing & commissioning

d. Trial run including service trial

e. Submission of Verified and As Built Documents.

4.2.5 O&M And Defect Notification Phase

The contractor shall develop a detailed Plan for Defect Notification Phase in consultation with the Engineer taking into account the Traction and E&M System/ subsystems/ equipment, Interface, RAMS demonstrations, Hazards not mitigated in the construction stage and carried forward to operation stage, maintenance support, T&P and spares created and the OEM's Recommendations on Maintenance support system etc. meeting the Operation & Maintenance requirement as under:

a. O&M activities,

b. Defect Notification Activities and plan,

c. Work shop Repair activities,

d. Support & Call out services,

e. RAMS demonstration and

f. Supply of O&M Manuals, Maintenance Schedules.

4.3 WORKS PROGRAM

4.3.1 The Works Program to be submitted under the contract shall be developed from the Outline Works Program as submitted by the contractor during the bid submission. The Work Program shall include a period for review by the Engineer/ Employer's Personnel of all stage of document submission while making overall project timeline adjusting various other activities. The Key Dates are given in Appendix-15 of the GS. All the Key Dates must be adhered with the Works Programme.

4.3.1 The Contractor shall prepare and submit for review by the Engineer, his proposed **initial version** of the Works Program which shall provide full program details for the first six months of the contract and shall provide outline details for the remaining period of the contract.

4.3.2 The Contractor shall prepare and submit the **full Version** of the Work Program subsequently for review and approval of the Engineer.

4.3.3 The Works Program shall demonstrate by reference to its Sub Programs, Supplementary Programs and associated Management Plans, the sequence and duration of the activities and any restraints there so that the Contractor shall adopt to achieve Milestones and to fulfill all Contract obligations. The Works Program shall become the basis of administration of the time-related aspects of the Contract.

4.3.4 The Contractor shall provide the Engineer with substantiation for each constraint whether target start, target finish or mandatory constraint entered by the Contractor into the Works Program. The number of constraints shall be kept to an absolute minimum.

4.3.5 The Works Program shall include activities for all the phases and stages of the Works, clearly showing all logical interdependencies and stages in the development of the Contractors design, procurement, installation, commissioning and setting to work. As a minimum, it shall include'

(1) All works comprising the permanent works;

(2) Preparation, submission and review of Design Documents showing all items where review by the Engineer is required.

(3) Procurement of all major materials and items of Contractor's Equipment for the Works, including the dates orders are to be placed, manufacture period and the expected delivery date to the Site for each item.

(4) Any software development requirements and Validation time frames.

(5) All manufacture or prefabrication of materials of components.

(6) All design and installation of major Temporary Works.

(7) All activities associated with securing necessary permits and other statutory approvals for the works.

(8) Access and availability dates for all Project Contractors.

(9) All interfaces related to the project that may affect the progress of the Works.

(10) Testing and commissioning activities requirements.

(11) Training.

4.3.6 The Works Program shall be divided into Sub-Programs of manageable size addressing in more specific detail. The Sub-Program shall be as follows:

(1) Design Submission Program

(2) Procurement Management and Manufacturing Program

(3) Co-ordinated Installation Program

(4) Testing and Commissioning Program; and

(5) Training Program

4.3.7 The submission of the '**full version'** of the Works Program shall include the Design Program, Procurement and Manufacturing Program and a preliminary version of the Installation Program and the Testing and Commissioning Program identifying all major installation, testing activities and associated interfaces.

4.3.8 The Sub-Program shall be further substantiated by the supplementary Programs as required by the Engineer.

4.3.9 The Contractor's Works Program shall comply with the following:

(1) All program submitted in both hard copy and electronic data format.

(2) All program shall be prepared using the latest version of CPM scheduling software Primavera Project Planner or similar.

(3) A standard Gregorian calendar shall be used for planning and execution of the Works. All Program submissions shall include details of the Contractor's allowance for Public Holidays and known-work periods. If a Milestone falls on a public holiday or non-work day it shall be effective the next working day.

(4) The planning unit for the duration of all Program activities shall be the day. Any activity having duration of more than 28 days shall be divided into sub activities

that shall not exceed 28 days.

(5) CPM program shall reflect status using remaining duration and percent complete.

(6) All program shall be fully resource loaded as appropriate or required by the engineer covering all stages and aspects of the Contract and shall include, but not be limited to:

a. Major manpower for both design and installation.

b. Number of items of Contractor's Equipment.

c. Number of drawings and other design deliverables.

d. Principal quantities of components or parts.

e. Principle quantities of bulk materials inclusive of cabling, pipe, ductwork and equipment item etc.

4.3.10 All programs constituting the Works Program shall be organized in a logical work breakdown structure including work stages or phases. Each activity shall be coded to indicate, as a minimum, the work group or entity responsible for the activity, the area, facility or location and the Cost Centre in which the activity is included, from information provided in the pricing schedules. Milestones shall be coded so as to be separately identifiable. The Contactor may be required to assign additional activity codes as required by the Engineer.

4.3.11 The Contractor shall make provision for the time required for completing the design, design reviews/ approvals, revisions, construction, procurement, manufacture, supply, installation, testing, commissioning and integrated testing of the Works.

4.3.12 This period shall include but not be limited to design co-ordination periods during which the Contractor shall co-ordinate its design with those of interfacing parties, review procedures, determining and complying with the requirements of all government departments and obtaining all necessary permits.

4.3.13 This period will include co-ordination with all others whose consent, permissions, authority or license is required prior to the execution of any work.

4.3.14 The Work Programs including supportive details and revised versions shall be submitted to the Engineer for his consent in accordance with the provisions of the conditions of Contract.

4.4 DESIGN SUBMISSION PROGRAM

4.4.1 The Contractor shall prepare the Design Submission Program (for Design Phase and Construction Phase) which is to set out fully the Contractor's anticipated program for the preparation, submission by the Contractor and review of the Design Packages, the issue of Notices by the Engineer for all stages of design. The 'Design Submission Program' shall cover all submissions during the Design Phase and the Construction Phase.

4.4.2 The Submission Program shall ensure that all submissions are properly co-ordinated with the Contractor's overall Works Program, particularly in respect of the following:-

(i) Progress of design,

(ii) manufacture, installation and testing work;

(iii) Co-ordination with other Contractors;

4.4.3 Due allowances for the Engineer review process and the time needed for any re-submissions to be undertaken.

4.4.4 The Design Submission Program shall:

a. be deemed to be consistent with relevant Coordination Dates and latest work program;

b. identify dates and subjects by which the Engineer's response should be made;

c. make adequate allowance for periods of 28 days for review by the Engineer with extra time for the review of other bodies, if necessary;

d. establish correlations by identifying, describing, cross-referencing and explaining the various Design Submissions including multiple submissions of the design for the different Work Segments;

e. make adequate time allowance for the design and development of the specialist works /sub-contractor works

f. indicate the interfacing design activities in respect of each of the other contractor / Interfacing Parties and external related parties and

4.4.5 The Contractor shall keep the Design Submission Program updated at intervals of not more than three (3) month throughout the Design Phase. Such updates shall be included as an exhibit in the Contractor's Monthly Progress Report.

4.5 PROCUREMENT MANAGEMENT & MANUFACTURING PROGRAM

4.5.1 The Contractor shall prepare and submit for review by the Engineer Procurement Management & Manufacturing Program that shall be an integrated part of the overall Works Program.

4.5.2 The Procurement Management & Manufacturing Program shall show the interdependencies between engineering disciplines as well as between the contractor and its subcontractors and suppliers. This Program shall demonstrate compliance with the requirements of the Submissions Program.

4.5.3 The Procurement Management & Manufacturing Program shall include a separate breakdown, supported by Material Controlled Schedule, which shall be a complete amplification of the Contractor's Program and equipment list, including those items which are subject to long lead time or component parts which are manufactured from countries outside the country of assembly and testing.

4.5.4 The Material Controlled Schedule shall be automated, and shall detail the following information for each permanent major and minor material and significant component. The format such a schedule shall include:

(1) Name, description, supplier/sub-supplier details.

(2) Drawing information (where appropriate), title, drawing status, submission dates, shop drawings/fabrication drawing preparation etc.

(3) The manufacturing process, manufacturing of test pieces, trial production, Engineer inspection, monthly production of components and monthly supply of components.

(4) The assembly process, erection and assembly sequences (particularly for the first pieces) prior to shipment, test assemblies, monthly assembly requirement, engineers inspection, testing of assemblies and

(5) Transportation process, quality release from factory, factory storage to dock and shipment.

4.5.5 The Contractor shall continuously maintain this schedule and report upon the status of each item as part of the contractors regular progress reporting.

4.5.6 From this base data, the Contractor shall prepare and an exception report detailing all components that are in delay. This report shall be annotated with the reason for the delay and indicate what action the contractor is taking to recover the lost time.

4.5.7 The Contractor shall submit, as part of the Procurement and Manufacturing Program, Factory Acceptance Testing Program that shall describe all activities of the Factory Acceptance Tests.

4.5.8 The Factory Acceptance Testing Program shall be fully detailed, with the activities individually identifying all tests for which a certificate will be issued, and shall include activities for preparation, submittal and review of the test procedures.

4.5.9 The Factory Acceptance Testing Program shall demonstrate the logical dependencies between the individual tests of the works, and shall also show the interfaces and dependencies with the Contractor's delivery Program.

4.5.10 The Factory Testing Programme shall include details of inspection, testing and witnessing of the contractor's and sub-contractor's procurement and manufacturing activities. As a minimum, it shall include:

(1) First article inspection;

(2) Quality Hold Points;

(3) Quality Control Points;

(4) Type Tests; and

(5) Routine Tests.

4.6 INSTALLATION PROGRAM

4.6.1 The Installation Program shall be submitted as stated in the PS or as directed by the Engineer. The Installation Program shall comply with the requirements of clause 4.3.10 above.

4.6.2 The Program shall include detailed activities describing all aspects of the installation of the works, to meet all Milestones given in the contract. It shall be clearly linked to the Design Program, Procurement Management & Manufacturing Program and Testing and Commissioning Program to form an integrated part of the Works Program.

4.6.3 The Installation Program shall be fully supported by the Procurement Management & Manufacturing Plan and Co-ordinated Installation Plan.

4.6.4 The Installation Program shall indicate the physical areas to which the contractors requires access, access dates, duration required and the required degree of completion for civil or architectural finishes prior to the access date.

4.6.5 The Installation Program shall take into account the requirements for arrival at port, delivery, storage, preservation and positioning of large items of the contractors equipment and permanent works and shall set out the contractors proposed delivery route for such items to the site.

4.6.6 All Installation tests shall be clearly shown in the Installation Program and shall include those interface tests required to be carried out by others to establish a time table for these tests.

4.6.7 Activities that may be expedited by the use of overtime, additional shifts or by any other means shall be identified and explained.

4.6.8 The Contractor shall highlight in his Installation Program any item, material, equipment, resource and support required from the 'Other Contractors with dates, duration and locations.

4.6.9 The Contractor shall ensure sufficient floats or slacks in all activities and avoid critical paths built in his Installation Program. In case critical paths cannot be avoided, the Contractor shall highlight any critical paths for the Engineer's attention.

4.6.10 In preparing the Installation Program, the contractor should note that the following conditions shall apply:

(1) The Contractor shall not have exclusive access to any part of the site except by the specific consent of Engineer.

(2) The Contractor shall take note that concurrent time allocations for certain areas may be given to more than one contractor. The contractor shall coordinate his works in such areas with that of project contractors through the Engineer.

(3) The absence of a Program date or installation period for the contractor in a specific area shall not prejudice the right of the Engineer to establish a reasonable Program date or installation period for that area.

(4) The Contractor shall propose contingency plan to ensure that all the major Milestones can be met in case there is slippage in the installation activities.

4.7 TESTING & COMMISSIONING PROGRAM

4.7.1 The Testing & Commissioning Program shall be submitted as stated in the PS or as directed by the Engineer and shall comply with the requirements of the clause 4.3.10 above.

4.7.2 The Contractor shall submit the Program that shall fulfill all the on-site testing & commissioning requirements. The Program shall clearly demonstrate the logic and highlight topics listed in the On-Site Testing and Commissioning Plan.

4.7.3 The Program shall be fully detailed, with activities individually identifying all tests for which a certificate will be issued, and shall include activities for preparation, submittal and review of the test procedures.

4.7.4 The Program shall demonstrate the logical dependencies between the individual tests of the Works, and shall also show the interfaces and dependencies with all of the Project Contractor's tests required to commission the Works and support the Commissioning Plan.

4.8 TRAINING PROGRAM

4.8.1 The Contractor shall prepare and submit for review by the Engineer, a Training Program covering all proposed formal training courses, delivery of training equipment and accesses by the Employer's personnel.

4.8.2 The Training Program shall be sufficiently detailed that the Employer can ensure the availability of staff for all the courses.

4.8.3 The Training Program shall include the requirements of Chapter-13: "Training and Transfer of Technology" including the Training activities of all sub-contractors and suppliers.

4.9 THE PROJECT CALENDAR

4.9.1 The Project Week shall commence on a Monday. A day shall be deemed to commence at 00:01 hour in the morning of the day in question.

4.9.2 Where reference is made to the completion of an activity or Milestone by a particular week, this shall mean by midnight on the Sunday of that week.

4.9.3 A 7-day-week calendar shall be adopted for various Works Programs which shall also display the rest day and holiday(s).

4.10 PROGRAM SUBMISSIONS

4.10.1 The Contractor shall submit all Programs described in this Chapter in conjunction with the Management Plans described in Chapter-3 of GS to the Engineer.

4.11 PROGRAM REVIEW

4.11.1 The Engineer shall, within 28 days of receipt of the initial submission of any Program for review, either give a notice of no objection or provide specific details as to why are notice of no objection is not given. If the Contractor is advised that the Program is not given a notice of no objection, the Contractor shall amend the Program taking into account the comments and/or requirements and resubmit the Program within 14 days.

4.11.2 In the case of further resubmittals, the resubmission time shall also be 14 days.

4.12 WORKS PROGRAM REVISIONS

4.12.1 The Contractor shall immediately notify the Engineer in writing of the need for any change in the Works Program, whether due to a change of Scheme, Design or circumstances or for any other reason. Where such a proposed change affects the timely completion of the Works or any Section or Stage: the Contractor shall within 14 days of the date of notifying submit for the review his proposed revised Works Program and accompanying Program Analysis Report. The proposed revised Works Program shall show the sequence of operations of all work related to the change and the impact of the changed work or changed conditions on the works and Project Contractors and their works.

4.12.2 If at any time the Engineer considers the actual or anticipated progress of the work reflects a significant deviation from the Works Program, he may request the Contractor to submit a proposed revised Works Program. Upon receipt of such a request the Contractor shall submit within 14-days a revised Works Program, together with an accompanying Program Analysis Report and Narrative Statement that shall demonstrate the means by which the Contractor intends to eliminate the deviation.

4.13 PROGRAM ANALYSIS REPORT

4.13.1 The Contractor shall submit a Program Analysis Report that shall, in narrative format, describes the basis and assumptions used to develop all Program submissions. The Program Analysis Report shall be prepared in a format having been reviewed without objection by the Engineer and contain as a minimum the following:

(1) Cycle times and work sequences;

(2) The deployment of Contractor's Equipment and labour;

(3) The production rates used in determining duration;

(4) The shifts assumed in determining duration;

(5) The breakdown of labour requirements by trades;

(6) The schedules of quantities used in developing the Program, to the extent that such information is not provided elsewhere;

(7) Interfaces with the Engineer and Project Contractor's and other constraints; and

(8) Any assumptions used in the Program.

4.13.2 The Program Analysis Report shall be in sufficient detail to enable the duration, leads and lags in logic diagram to be reconciled and substantiated, and to enable the projected levels of labour (by trade) and staff and flows of goods, materials and equipment to be substantiated.

4.14 MILESTONES

Milestones have been derived from Conditions of Contract. These are the broad key deliverables and Contractor is required to develop project program to achieve these deliverables and dates. Accordingly contractor should set his own internal targets which are commensurate with these Milestones and incorporate in his all internal schedules for approval of Engineer. The details of Milestones are mentioned under appropriate clauses in Part 3, Section VIII of Bidding Documents.

4.14.1 Milestone Report

(1) The Milestone Report shall be prepared in a format reviewed by the Engineers Representative and identify and state the status of :-

a. All Milestones that are planned to be achieved in the reporting period or earlier but have not been achieved;

b. All Milestones that have been achieved in the reporting period;

c. All Milestones that are planned to be achieved in the next reporting period; and

d. Any Milestones that appear unlikely to be achieved on time.

(2) The Milestone Report shall identify for all relevant Milestones, the planned dates, the actual dates achieved, and where the original planned dates are forecast to be unachieved, the revised dates identified in the contract, as the same may be revised time to time in accordance with the contract.

(3) The Milestone Report shall also provide an explanation for any deviation from the planned dates. Measures taken or required to recover the Program delays shall also be identified.

4.15 MONITORING OF PROGRESS

The Contractor during the progress of the Works shall constantly monitor its own and its subcontractor's performance to ensure its compliance with its obligations under the Contract and progress as per agreed Work Program. The Monitoring of the Works shall include direct daily monitoring of the progress of the Works and preparation of written and computerized reports to be submitted to the Employer's Personnel and the Engineer as required. The Progress reports submitted shall include all necessary supporting data of the status of the completion of the Works including preparing and submission of PERT/ CPM/ BAR/ GANTT charts and "S" Curves.

4.16 PROGRESS REVIEW MEETINGS

4.16.1 The Engineer/ Employer's Personnel will conduct Progress Review Meetings (PRM) to be held monthly with the Contractor at appointed dates and times.

4.16.2 The Employer's Personnel /Engineer may convene at his discretion, at any time upon reasonable notice to the Contractor, any meeting, either on or off the Site, to discuss and address any aspect of the Works or the Contract.

4.16.3 The Contractor shall attend monthly Progress Review Meeting or any other meetings called by the Employer's personnel / the Engineer in order to review the arrangements for future work, Works in progress or other issues set out in the Meeting Agenda. The meetings shall be attended by the nominated Project Manager/ Deputy Project Manager(s) of the Contractors, and his support Experts of Relevant fields/ activities and other Senior personnel who shall arrive properly briefed for all aspects of the meeting and shall be empowered to make executive decision in respect of the execution of the Works.

4.16.4 The Minutes of the Meeting (MOM) signed & issued by the Engineer shall constitute an official record of matters discussed. However, such MOM shall not replace or dilute any of the Employer's requirement specified in the Contract. The Contractor shall take specific approvals, instructions or decisions in writing from the Engineer for all documentations and submissions as specified. Such meetings may be attended by representatives of all Interfacing Parties and other stakeholders as deemed fit by the Engineer.

4.16.5 A first meeting as a 'Kick off Meeting" of the work/project shall be organized within two weeks of 'Letter of Acceptance (LOA)'. The meeting shall be attended by Contractor's Representatives and Employer's Personnel / the Engineer. During the meeting the activities related to the project planning, scheduling, and monitoring and control shall be discussed and finalized as required including planning on deliverables for project monitoring & control, Works Program and other Inputs as desired by the Employer.

4.17 MONTHLY PROGRESS REPORT

4.17.1 The Contractor shall prepare Monthly Progress Reports covering all aspects of the execution of the Works. Such Monthly Progress Reports shall be in writing and shall be delivered to the Engineer by the 7th day of the month following the month of Monthly Progress Report. The Monthly Progress Report shall take account of work performed up to and including the last day of the month to which the monthly progress report relates and shall be prepared in accordance with Chapter-15, Appendix-1: "Monthly Progress Report".

4.17.2 The Monthly Progress Report shall include an executive summary and contain clear and concise statements in respect of every significant aspect of the Works including, without limitation, the requirements specified in this Specification.

4.17.3 The Monthly Progress Report shall contain evidence that document and supports the progress of the Works to the satisfaction of the Engineer.

4.17.4 The Reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work to be accomplished and shall provide the Engineer with a sound basis for identifying problems and deviations from planned work and for making decisions.

4.17.5 Important events, construction/Installation activities working of new machinery, weather effects or any occasion advised by the Engineer shall be video graphed. The recording shall be done or converted to .avi format and presented in electronic storage device with appropriate voice recording describing the event.

4.18 QUARTERLY REVIEW MEETINGS

4.18.1 The Employer may convene Quarterly Review Meetings at approximately three months intervals. The Engineer will notify the Contractor the date of such Quarterly Review Meetings not less than 14 days before they are to be held.

4.18.2 Quarterly Review Meetings shall be held to review the overall progress of the Works in the context of the Project as a whole and to address and resolve any issues relevant to the execution and progress of the Works. Such Quarterly Review Meetings will be chaired by the Employer or his delegate. The Contractor shall have in attendance of one senior representative of the Director level from each of the companies acting as leader or sponsor of the Contractor if it is a Joint Venture, Consortium or Partnership whenever necessary and required by the Engineer.

4.19 IT REQUIREMENT FOR HRIDC

4.19.1 "HRIDC shall be in the process of implementing an Enterprise wide IT System. In view of ERP package SAP being implemented in HRIDC, Contractor must provide the following data to HRIDC Head Office/CPM Offices in the Microsoft Excel Templates/Format released by HRIDC Head Office/CPM Offices.

4.19.2 As part of scope of work the Contractor will ensure the following:

(1) Ensure that required data of the Contracts Work Program and Physical progress of the activities defined in the Works Program must be provided in the templates defined by HRIDC to be uploaded in the system using software defined by HRIDC.

(2) Work Program, Revised Works Program and Revision in Planned Work in the Activities, would also be uploaded in the system using software defined by HRIDC through templates provided by it.

(3) In order that the Works Program Data provided by the Contractor could be uploaded as it is in the system, Contractor must adhere to the following conditions regarding the length of the Codes/Numbers defined in their project Management Tool (e.g. Primavera or Microsoft) for the Project Structure Elements:

a. Project ID/WBS Element Codes/Numbers must be unique and must not exceed a maximum length of 20 Characters (Alpha Numeric).

b. Activity IDs/Numbers must not exceed a maximum length of 4 Characters (Alpha Numeric).

(4) Upload of drawings and designs created by Contractor as per the classification using document management system of SAP.

(5) Online measurement book entry (Record of Works) and all bills along with supporting documents as per the screens defined by HRIDC.

(6) Asset details needs to be updated in the system in format prescribed by HRIDC.

(7) GIS (Geographical Information System) application will use Autodesk suite (MAP 3D as desktop GIS & AIMS for WEB GIS) and Oracle 11g/spatial as a central

repository. Information about the assets details (i.e. alignment drawing coordinates and attributes) will be provided by the contractors. Network asset details in the form of maps, reports will be available to all the authorized users through web as soon as the asset details are submitted by the contractors and imported in the system.

a. Geo-referencing of alignment on WGS-84 coordinates.

b. Capture and upload of geo-referencing coordinates of the assets in to GIS.

4.19.3 Contractor need to feed/provide the data in the IT system as per mechanism and method devised by HRIDC. For putting data into system Contractor needs to make arrangement of connectivity, if required and also needs to bear the cost of any licensees required for the Contractor to access the HRIDC IT System.

4.19.4 In case interoperability is required for movement of information and data in a seamless manner between contractor IT system and that being developed by HRIDC, it will be the responsibility of the Contractor to ensure the same.

(End of Chapter 4)

CHAPTER 5 - DOCUMENT MANAGEMENT

5.1 GENERAL

5.1.1 During the life cycle of a project, contractor would be required to produce different types of documents to facilitate the planning, tracking/ monitoring progress and reporting of the project. Documents range from Studies/ Reports, Management Plans, Resource plans, financial plans and project Implementation Program, Design & Process documents, Calculations, Drawings, Vendor Technical Specifications, supplier contracts, post-implementation reviews, change request forms and project status reports etc.

5.1.2 It shall be ensured by the Contractor that documentation meets the Purpose and the content is sufficiently detailed to communicate fully. Success of project is crucially dependent on documents produced for it.

5.1.3 The Contractor shall maintain a PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS) and share the information with the Employer's PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS) as per details in Chapter-15, Appendix-7: "PMIS Requirements and Procedures".

5.1.4 The Contractor shall comply with the following requirements of the Employer regarding the Document Management System.

- Document Flow Process,
- Document Approval Process,
- Document and Drawing Numbering System,

5.1.5 The Contractor shall submit hard copies of all drawings, data of the documents and copy of transmittal along with a soft copy transfer electronically in the agreed format. Contractor will share the softcopies as advance information. However the reviews will only be made on hard copies and shall be preserved in hard copies with endorsed signed copy. The work shall be executed based on the latest hardcopies of the drawings and documents.

5.2 TYPES OF DOCUMENTS

5.2.1 The Contractor shall identify the requirement of Documents, designs, drawings and furnish a Document Management Plan. Types of documents that would be required to be submitted by the contractor are as enumerated below but not limited to:

1) Reports and Studies

Inception Report, Simulation study, Site Survey reports, Monthly / Quarterly Progress Report, Inspection Reports, Notes of Discussions/ Minutes of Meeting(MOM)/ Investigation Reports etc.

2) Project Management Plans

As per Chapter 3

3) Programs & Schedules

As per Chapter 4

4) Process & Procedures documentations

Specification Design/ document/ Drawing submission, approval of technology/ equipment, Method Statement, Makes, Alternate options, Design Change, site access, handing over, etc.

5) Design phase submissions

Design phase submission will constitute the following :

a. Preliminary Design Submissions along with Design Report, Scheme/ Drawing, Calculations and supportive documents;

b. Detailed Design submissions along with Design Report, Scheme/ Drawing, Calculations and supportive documents;

c. System Requirement Specifications, Proofs & Evidences of achieved System assurance and RAMS with V&V, Check lists and

d. Vendor Performance Specifications and Drawings.

6) The manufacturing / supply phase will constitute Manufacturing by OEM Factory Acceptance Tests (FAT) and delivery to the contractor's stores at site.

7) Construction / installation, testing and commissioning phase submissions will constitute the following:

a. Equipment installation drawings,

b. Construction Reference Drawings,

c. Interface Management and combined Services Drawings,

d. Monitoring, Control & Protection Logics and fault diagnostics,

e. O & M and Design Manuals with Itemized specifications, monitoring & Control Process, Diagnostics and O&M procedures with test results reports,

f. As built drawings with Drawings for all equipment and sub-systems/systems supplied & installed, location wise Equipment Bill of quantity, Asset Register,

g. RAMS demonstrations reports and

h. Process papers for Permits and approvals.

5.2.2 For the Equipment, sub-system and components therein, the Contractor shall submit documents and drawings describing function description, product description, interface requirement description, RAMS requirement description, Life cycle calculations, type test & routine test specifications, list and details of spares, related calculations etc.

5.3 DOCUMENT CONTROL PROCEDURE

5.3.1 Within 28 days after Commencement Date, the Contractor shall submit a Document Control procedure to the Engineer for review as below but not limited to;

a. The document shall be well organized. It shall have a clear logical sequence and should be organized in chapters, sections, and sub-sections with meaningful headings, including diagrams, tables, or figures whenever appropriate.

b. The document shall be self-contained as far as possible without much cross references, unless otherwise there is a reason to do so.

c. The Contractor shall use configuration management to ensure that the system is correctly configured. The Contractor shall ensure that a configuration control program is maintained. The Program shall ensure that the configuration of each item is recorded and maintained during the life of the Contract including Defect Notification Period.

d. Every document and drawing shall have a unique traceability. The Contractor shall ensure that all submissions are correctly numbered in accordance with the schedule. The sequence code shall be a unique sequential number for each submission for each particular subject. Revision numbers shall be used when a re-submission is required. The resubmission shall have the reference of the previous revisions including the revisions of the references used in the drawings and documents to ensure traceability.

e. Each Document and Drawing shall have a title, Document number, Revision Number, Date and list of Reference documents/ drawings (along with Reference Number, Revision and Date). The revision status and date of preparation of the submission shall be clearly indicated at the header of each page of the submission.

f. The Documents and CAD drawings shall be described, Titled, numbered and detailed as per the Appendix-2 of this GS.

g. To establish integrity of the Document / Drawings, each sheet / page of the submission shall be sequentially numbered giving page number of the document with reference of total pages i.e. x page no. of y pages. Every Para of the document shall be sequentially numbered without duplication of para numbers.

5.3.2 Each document shall be accompanied by a brief Explanatory Notes / introduction / Report to explain the Purpose**,** which subsystem - part of the Works to which the submission refers to, lists of the documents enclosed, with the submission and describing in outline how all relevant requirements of the Employer's Requirements are achieved by the proposals.

5.3.3 The Contractor's document approval system shall specify the level of authority for approval of all documents before submission to the Engineer and in accordance with Quality Assurance.

5.3.4 The system of issuing documents shall ensure that pertinent documents are issued to all appropriate locations.

5.3.5 A document change or re-issue system to ensure that only the latest revision of a document can be used; and should contain:

i. Contract number;

ii. Discipline;

iii. Submission reference number;

iv. Revision indicator and date; and

v. Description of Change for each revision with clouding and flagging in the drawing.

5.4 REQUIREMENTS OF DOCUMENT SUBMISSION

5.4.1 All the documents, drawings and Designs shall be submitted with the endorsement thereon the Documents as under:

a. Certificate of the contractor in the effect that "the submission is prepared, checked and issued by the qualified engineers of the Contractor" conform to the satisfactory, safe and reliable performance,

b. Statement of Exception/ Deviation from the Contract: 'NIL'

5.4.2 Deviation if any to the particular specification shall be got approved before implementation from the Engineer in writing and endorsed in this effect on all documents affected by such deviation.

5.4.3 The documents involving Field changes in the approved design or due to site constraints shall be endorsed by the contractor with a Statement of "NO additional financial implication" unless approved otherwise by the Engineer.

5.5 DRAWINGS PRODUCED BY THE CONTRACTOR

5.5.1 Drawings produced by the Contractor shall generally be ISO A-1 size or as desired by the engineer for the followings;

a. Schematics,

b. General Arrangement Drawings,

c. Site layouts, Equipment layouts,

d. Construction Reference Drawings of Permanent works,

e. Combined Service drawings,

f. Detailed Interface Drawing,

g. Drawings for Temporary Works etc. and

h. Revised drawing due to design/ site changes.

5.5.2 They shall display a title block with the information as detailed herein Drawing and CAD Standards duly quality checked and Sign endorsed by the Preparer, Checkers and issuer along with the Design Certificate.

5.5.3 The contractor shall provide six sets of all stage drawings along with read only electronic version of the same on Electronic Media to the Engineer.

5.6 LEVEL / QUANTUM OF SUBMISSION

The Contractor shall adopt top-down approach and carryout submissions of the following levels in a logical sequence for review by the Engineer:

a. System works related submissions shall show the total system including the configuration block diagrams, operating principle, system features and functions, capacity, expandability, interconnection within the subsystem, between subsystems and between other Contract Packages.

b. Equipment level related submissions shall show the specification on electrical, mechanical and functionality of the equipment/materials employed for the system and the subsystems.

c. Design calculations shall demonstrate the performance of the system and subsystems.

d. Installation Design related submissions.

e. The Contractor shall submit supportive documents, copy of certificates from relevant parties and authorities as required.

f. Equipment test certificates, Reports, calibration certificates from manufacturers and laboratories.

5.7 DOCUMENT SUBMISSION PROGRAM

5.7.1 The Contractor shall submit documents for all the stages - design, manufacturing/supply and Installation, testing and commissioning etc. to the Engineer for 'No Objection'.

5.7.2 The Contractor shall submit a Document submission Program. The submission program shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates for Management Plans and the Drawings of each stage.

5.7.3 Submission of Unlisted or undefined proposals / alternate proposal shall not be part of Document Submission Program however shall be addressed in the same manner.

5.7.4 The Document Submission Program shall:

a. Be consistent with and its principal features integrated into the Works Program, and show all relevant Milestones and Key Dates;

b. Identify dates and subjects by which the Engineer's decisions should be made;

c. Make adequate allowance for periods of time for review by the Engineer and other review bodies;

d. Indicate the design interface and co-ordination periods for each Other Contractor;

e. Include list of requisite design details for each and every component or equipment of all sub-systems and systems and

f. The Contractor shall update the Submittals Schedule suitably in accordance with the observations of the Engineer if any deviations**.**

5.7.5 The Contractor shall submit the Document Submission Program to the Engineer as indicated in Chapter-3 of this GS, and thereafter up-dated versions thereof at intervals of not more than 3 (three) month.

5.8 DOCUMENT SUBMISSION PROCEDURE

5.8.1 For each stage of submittal, the Contractor shall prepare a Submission Response Request (SRR) carrying the date of submission, the submission reference number as defined above, the submission title, the stage of submission (e.g. Inception Report, Simulation Report, Detailed Design, etc.), and the signature of the Contractor's Representative:

5.8.2 The Documents and Drawings shall be submitted under the signatures of the Project Manager of The Contractors to establish proper issue & Control of the documents. The authority will not be delegated below the rank of Project Manager.

5.8.3 The submission shall be accompanied with a checklist duly signed (with name) by the Preparer and Checker of the Drawing/ document.

5.8.4 The submission shall be accompanied with Exception Statement on Deviations if any to the Specifications.

5.8.5 Each Document / drawings shall be signed by the Preparer (who has prepared the Document/drawing), the Checker (who has checked the document/ drawing) for conformance to specifications, and the issuers (who has verified the document for the purpose, and issued after Careful examination) to demonstrate that document have gone through the process of quality assurance.

5.8.6 All the documents, drawings and Designs shall be submitted with the endorsement thereon the Documents as under:

a) Certificate of the contractor to the effect that "the submission is prepared, checked and issued by the qualified engineers of the Contractor and has been properly reviewed by the Contractor, according to the Contractor's Project Quality Assurance Plan", thereby confirming its completeness, accuracy, adequacy and validity and conformance to the satisfactory, safe and reliable performance,

b) Compliance with all relevant clauses of the Employer's Requirements;

c) Conformance to all interface requirements;

d) Certifying that it is based on auditable and proven or verified calculations or design criteria;

e) Has taken account of all requirements for approval by statutory bodies or similar organizations, and that where required, such approvals have been granted;

5.9 ENGINEERING REVIEW COORDINATION

5.9.1 Throughout the Design Stage, the Contractor shall attend monthly design review meetings with the Engineer. At these Engineer's review meetings, the Contractor shall present information, drawings and other documents to the Engineer in respect of all submissions Program to occur during the following four week period. The Contractor's presentations shall be in sufficient depth to enable the Engineer to obtain a clear understanding of the Contractor's proposals and to discuss the methodology and process used in reaching the proposed design solutions. Unless otherwise directed by the Engineer, all meetings shall be convened in Engineer's Office or Contractor's Main Office or at the Site Office or at any other location as decided by the Engineer.

5.9.2 The Contractor shall record all of the Engineer's observations and any agreed actions resulting from the Engineer's review meeting and shall address each of these fully before submission of the respective documents for formal review.

5.10 ENGINEER'S REVIEW

5.10.1 The Engineer will complete his review of the submission within 28-days, and communicate review comments in writing or on marked up drawings/documents.

5.10.2 Within two weeks of the receipt of the Engineer's comments the Contractor shall resubmit the submittals/ documents needing resubmission.

5.10.3 Where the comments are minor, the same may be clarified by calculations, part prints, etc. as acceptable to the Engineer and included in the Contractor's next submission.

5.10.4 Should the Engineer considers the submission to be unacceptable, the Contractor shall revise and re-submit the entire submission within two weeks, unless otherwise agreed with the Engineer.

5.11 ENGINEER'S RESPONSE

1) The Engineer will respond in one of the following three ways:

a. Notice of No Objection

b. Notice of Objection (With "A" Comments)

c. Notice of No Objection with Comments

2) Definition of Engineer's response:

a. "Notice of No Objection": if following his review of the submission, the Engineer has not discovered any non-compliance with the Contract, the Engineer will issue to the Contractor a formal "Notice of No Objection" (NONO). A NONO from the Engineer, irrespective of with or without comments does not in any way imply the Engineer's consent of the submission nor does it remove any responsibility from the Contractor for complying with the Contract. Issue of a NONO from the Engineer entitles the Contractor to proceed to the next stage of the Programed work.

b. "Notice of Objection (With "A" Comments)": if following his review of the submission the Engineer discovers major non-compliance, discrepancies or omissions etc. that in his opinion are of a critical nature, the Engineer will issue a "Notice of Objection" (NOO) with type "A" comments. The Contractor shall revise and reissue the submission addressing the Engineer's comments. Following the issue of a NOO by the Engineer, the Contractor is not entitled to proceed to the next Programed stage on the path in the relevant network as previously approved by the Engineer until all of the Engineer's comments have been fully addressed and a NONO is issued.

c. "Notice of No Objection" (With Comments)": if following his review of the submission the Engineer discovers discrepancies or omissions etc. that in his opinion are not of a critical nature, the Engineer may issue a "Notice of No Objection" (NONOC) with Comments. The Contractor shall respond to the comments, agreed and incorporated prior to inclusion in the "Construction Package" Following the issue of a NONOC by the Engineer, the Contractor is entitled to proceed to the next stage of the Programed work subject to the inclusion of amendments necessary to address the comments.

(End of Chapter 5)

CHAPTER 6 - DESIGN REQUIREMENT

6.1 GENERAL

This Employer's Requirement identifies the Design requirement for execution of the HORC 2x25kV AC Electrification and associated woks including the preparation and submission of the design of the Systems Works and it shall be read in conjunction with the 'Design Criteria,' Basic Design Philosophy and Requirements for Design and Project Quality Assurance Plan as described in this General Specification (GS) and Particular Specification (PS) and other relevant Appendices. These requirements are subdivided into Design Phase and Construction Phase, and those that are of general application.

6.1.1 The Works shall be executed in four phases viz. the Design Phase, the Manufacturing/Supply Phase, Construction/ Installation Phase and Testing & Commissioning Phase.

6.1.2 The various phases of the project will overlap with each other. The Design Phase shall have 4 stages – Preliminary Design Stage, Detailed Design Stage, Construction/Installation Design Stage and As Built Documents Stage, overlapping with the various phases of project execution.

6.1.3 The Contractor shall ensure that his design is accurate and in compliance with Employer's Requirements and the Specifications which are deemed to be part of the contract as defined in Conditions of Contract. The Contractor shall be responsible to ensure that when the Works are completed, the same shall be fit for the intended purpose as specified in the Contract.

6.2 GENERAL DESIGN CRITERIA

The system designed by the Contractor shall meet the application duty requirement during its serviceable life as envisaged and shall be aesthetic, User friendly, Modular, Expandable, Durable & Maintainable, Environment Friendly, Energy Efficient, EMC/EMI compatible, High Designed life as per the Industry Benchmarks, Meets the Reliability, Availability and Maintainability Standards, interfaced seamlessly with other systems in conformance to safety standards and the specifications

6.2.1 Durability and Maintenance

(1) The Permanent Works shall be designed and constructed such that they shall endure in a serviceable condition throughout their design lives as described in the Design Criteria and standards contained in the PS and technical specifications to minimize the cost of operation and maintenance whilst not compromising safety or the performance characteristics of the railway.

(2) Equipment(s), where supplied, shall be of a quality and durability to fully meet the performance and operational requirements described in the Design Criteria.

6.2.2 Operational Requirements

(1) The Permanent Works shall be designed to permit the HORC to operate optimum number of trains per hour satisfactorily at a maximum permissible speed for freight trains in accordance with Particular Specifications.

(2) It is a requirement that the Indian Railway (IR) remains operational during the

construction / Installation phase.

6.2.3 Aesthetics

The Permanent Works shall be designed to achieve an aesthetic character and provide a feeling of design commonality throughout the project.

6.2.4 Human Factors

The Contractor is required to observe the guidance contained within ISO/TR 16982:2002 and the ergonomic design of systems supplied shall be subject to acceptance by the Engineer.

6.2.5 Safety, Health and Environment Considerations

The design of the Permanent Works shall be according to Indian laws and regulations related to Safety, Health & Environment Requirements. Safety, Health & Environment aspects shall be kept in mind during the Design/Construction/Installation and Testing & Commissioning phases, requirement for which has been specified at appropriate places in the bidding document**.** It shall be the overall responsibility of the Contractor to ensure compliance of Safety, Health & Environment aspects at all times conforming to the provisions mentioned in this Bidding document.

6.2.6 Quality Control

Quality control aspects shall be kept in mind during the Design/construction/Installation and testing & commissioning phase, requirement for which has been specified at appropriate places in the bidding document. It shall be the overall responsibility of the Contractor to ensure deliverables of quality products at all times conforming to the provisions mentioned in this bidding document.

6.2.7 Reliability, Availability, Maintainability and Safety of Design.

The System Design shall ensure Reliability, Availability, Maintainability and Safety standards, as specified in the Bidding document.

6.3 OBLIGATIONS AND RESPONSIBILITIES OF THE CONTRACTOR

6.3.1 The Contractor shall be responsible for the design, layout, construction/Installation, manufacture, supply, testing and commissioning of the 2x25kV AC Electrification and associated woks under the scope of this package and shall ensure that the designs are accurate and in compliance with Employer's Requirements of Particular Specifications (PS) and General Specifications (GS).

6.3.2 The Contractor shall be fully responsible for the suitability, adequacy, integrity, durability and practicality of the Contractor's proposal. The Contractor shall ensure that the Works are fit for the intended purposes meeting application duty requirement.

6.3.3 The Contractor shall undertake that the designers shall be available to attend discussions with the Engineer and Employer at all reasonable times during the Contract period. The Designer shall be the same entity as proposed by the Contractor at the time of pre-qualification unless otherwise approved by the Employer. The Contractor shall furnish Designer's Warranty in the format provided in contract forms of bidding documents.

6.3.4 The Contractor is responsible for assuring the quality of the System designs and shall produce and establish a Quality Management System specifically to meet the Contractual Obligations and Quality Assurance Plan as referred in GS and the PS.

6.3.5 The Contractor shall ensure that the system Designs conform to Safety, Health and Environment requirements as specified in this GS, and Project SHE Manual as detailed in this Employer's Requirements.

6.3.6 Wherever there is any inadequacy in the Employer's Requirements, the Contractor's proposal shall take into account, address or rectify such inadequacy, insufficiency, impracticality or unsuitability. If there are discrepancies between documents referring the same subject, the more stringent criteria shall normally be followed, unless otherwise the order of precedence described in the relevant documents is not applicable.

6.3.7 All technical solutions, schemes and materials etc. shall be fully compatible with those used by the beneficiary and should not be in conflict with the applicable rules / codes / manuals and standards as well as legislations in India.

6.3.8 The Contractor shall co-ordinate with the Other Designated contractor's viz. Civil, Building, Tunnel, Tracks and S&T and the Contractors working at adjacent sections of HORC etc. to meet the Interface requirement Obligations specified in the Interface Matrix and Interface Management Plan.

6.3.9 To demonstrate the compliance to Quality assurance, all the documents, designs and the Drawings shall be signed (with name) /endorsed by;

a. who has Designed / prepared,

b. who has checked,

c. who has issued the drawings/ document i.e. the Senior Design Engineer of the Contactor's Design Team.

6.3.10 The Contractor shall certify that:-

a. The Works have been or will be designed, manufactured, installed and otherwise constructed and to the applicable standards available using proven up-to-date good practice.

b. The Works will, when completed, comply with enactments and regulations relevant to the Works.

c. The design of the Works have taken or will have taken full account of the effects of the intended manufacturing and installation methods, Temporary Works and Contractor's equipment.

6.3.11 The Contractor shall also provide an undertaking from the Designer for his Designs for suitability, adequacy, practicality and absolutely meeting the Employer's Requirements as detailed in Chapter-15, Appendix 3: "Design Certificate". The undertaking shall also state that reasonable skill and care expected from a professionally qualified and competent designer experienced in works of similar nature has been exercised. This shall be applicable for such Designs which may be or have been prepared, developed issued by the Employer, or any of Contractor's consultants, his sub-Contractors and/or his qualified personnel/persons or cause to have been prepared, developed or issued directly or indirectly by the Contractor. All the aforesaid shall be applicable notwithstanding the fact that any part of the work may have been inadvertently accepted, passed and paid for by the Engineer or Employer. The Contractor shall endorse a design certificate in requisite format thereby demonstrating that the Designers have fully checked the design as being compliant with all QA procedures and fully compliant with the requirements of the Contract.

6.3.12 The Contractor shall, whenever the Engineer so requests, provide information and participate in discussions/ presentations that relate to design matters.

6.3.13 Contractor shall furnish all the information as required and as consulted by the Employer in regard to Public Consultations, as specified in Publicity and Public Relations to this Employer's Requirements.

a. all plans, programs, reports, calculations, manuals and drawing as specified in 'Document Submission Plan' of this Employer's Requirements and in accordance with this GS and PS of the Systems work to the Engineer to seek the consent of the Engineer and issue "Notices of No Objection".

b. additional information and supportive documents as required by the Engineer to verify the requirement and / or required for co-ordination of the design of Other Contractors.

c. The Designs within the specified dates as per 'Document Submission Program' of this Employer's Requirements.

6.3.14 Contractor shall submit the Preliminary Designs, Detailed design, Construction Design, As-Built Documents and other design Documents as specified in Quality Assurance Requirements of this Employer's Requirements.

6.3.15 The Contractor shall carryout Engineering studies and comparative evaluations to ensure that the designs incorporate features to achieve optimum performance of all elements. The design of 2x25kV AC Electrification and associated woks shall be reliable, energy and cost efficient with due considerations to the local climate conditions, safety, ease of installation, operation, maintenance and future replacements.

6.3.16 The Design shall include the Design Calculations in soft and hard copies in verifiable forms including the relevant formulae, Schematics & drawings, Design Manual and checklist etc.

6.4 CONTRACTOR'S ORGANIZATION DURING DESIGN PHASE

6.4.1 Project Organization

a. Within 28 days of Commencement Date, the Contractor shall submit the Project Organization chart (as a part of Mobilization plan) during the Design Phase, equipped with the functions in a manner as described in 'Quality Assurance Requirements' of this Employer's Requirements. The Plan shall show the management structure and state clearly the duties, & responsibilities and authority of each key and staff member. The Contractor shall keep this plan updated and resubmitted whenever there are changes in the Manpower mobilization plan.

b. The Contractor shall establish a Design Office at his Main Site Office or at a place agreed by the Engineer.

c. The Contractor's Personnel/team shall be deployed as per the Mobilization plan.

d. The Contractor shall propose and deploy qualified, experienced & competent personnel appropriate to the type and magnitude of the design involved in the Design Team with the Engineer's consent for each key personnel during the Design Phase. Full details regarding their qualifications and experience shall be submitted to the Engineer for his consent.

e. The Contractor's Design Team shall be independent of the Construction Team in his Organization. The Design team shall be carried forward to construction phase design to ensure that the Contractor's design development strictly complies with the Detailed Design which has received 'Notice of No Objection' from Engineer.

f. ll meetings and discussions relating to design shall be held in the Design office or in the office of Engineer/Employer and/or as instructed by the Engineer.

g. The Contractor shall ensure that the Design Team continues to be represented at Site at all times by staff whose seniority and experience are to the satisfaction of the Engineer and whose representative is available on the Site as necessary or as required by the Engineer.

h. The Contractor shall replace a person of the Design Team immediately if the Engineer/ the Employer's Personnel seek a replacement citing the reasons. The Contractor shall ensure that the demobilization of the person from the site/ office within seven (7) days of the advice and shall have no further connection with the Works in the Contract.

6.5 EMPLOYER'S DRAWINGS & DOCUMENTS

The Employer's Data and Drawings are attached in this Contract Package Part 2, Section VII-3 : Reference Documents 'Employer's Data and Drawings' respectively to express the Employer's concept and /or intent bearing functions, purposes and structural forms of the Permanent Works as detailed hereunder:

(1) Alignment Drawings

a. The Alignment Drawings basically contains the Indicative Horizontal and Vertical Alignment of the Track-ways for the whole Mainline, Connecting Lines, Loop Lines, Sidings (yard layout for each Station) and connecting lines to IR etc. under the Contract; and also the Definite Right of Way (ROW) available all along the Alignment including the Junction / Crossing Stations in line with the list of ROW attached herein as 'Part – 2, Section VIi-3 – Reference Documents.

b. The Alignment Drawings enclosed in the Employer's Drawings are indicative and are further subject to confirmation from the Other Designated Contractor(s) viz., CST.

c. Contractor shall be responsible for the information's' use, correctness, adequacy and applicability.

d. Contractor will be responsible for verifying its correctness for his own designs portion of the Design stipulated in the Particular Specifications.

e. The Contractor shall also ensure that during the Design development the designs include complete scope of work

f. The contractor's design shall be consistently developed without infringing the Right of Way, the Structure Gauge and the Clearances as stipulated in the Specifications.

g. The locations and Chainages are tentative and indicative only. It is the Contractor's sole responsibility to verify their precise nature and location before undertaking the Detailed Design.

(2) General Arrangement Drawings (GAD)

a. The Employer's General Arrangement Drawings (GADs) are a set of reference drawings which shows the Employer's concept of each Permanent Works above, are indicative and for reference only. These shall be further developed by the Contractor as part of Detailed Design/ drawing as relevant and shall be coordinated with Other Contractors.

a. The GADs as relevant to this package are included in the Part – 2, Section VII-3 – Reference Documents.

(2) General Drawings – Containing the general map of the alignment route and the Site location map,

6.6 CONTRACTOR'S REVIEW OF EMPLOYER'S DESIGN & DRAWINGS

The Contractor shall review the indicative General Arrangement and other Drawings and suggest his modifications and improvements based on site conditions and as a result of the Simulation Study conducted by him and approved by the Employer.

6.7 VALIDATION OF DATA & ADDITIONAL SURVEYS

6.7.1 The Contractor shall verify the available data for adequacy and applicability. The Contractor shall plan and Program for the validation of the drawings and data provided by the Employer.

6.7.2 The Contractor shall conduct additional surveys if required as below:

a. Survey for Earth Resistivity as appropriate to achieve the required earth value, touch and step potential.

b. Electromagnetic Interference from AC traction currents and to mitigation measures of adjacent circuits and ensuring safety. Special precautions and preventive measures which may become necessary against EMI for any adjacent continuous metalwork such as fencing, wires and cables affecting safety to the public or to the circuits from induction effects of 2 x 25 kV, 50 Hz, AC traction currents or for foundation designs for the Traction Structures, passage of OHE through over line structures and tunnels, those affecting adjacent IR lines in operation or any other purpose as considered necessary. The Contractor shall carry out his own independent survey and inform the Employer of the results of such survey recommending the mitigation measures.

c. The Contractor shall design and provide the mitigation measures for the entire installation to be provided by him. In regard to the mitigation measures to be taken on the installation of outside bodies and Indian Railways, the Employer shall decide the agency through which such mitigation measures shall be taken up.

6.7.3 The contractor shall conduct surveys as required for Contractor's Simulation Study under the scope of work specified in Particular specifications. Based on the final validation Survey and additional survey the contractor shall formulate a proper preliminary design parameters for finalizing the Detailed /Construction designs.

6.8 RESIDUAL & SUPPORTIVE WORKS TO DELIVER THE PERMANENT WORKS

a. It shall be the Contractors responsibility to carry out all the residual/ supportive works as essential to deliver the Permanent works and take precautions necessary to ensure that the survey works are accurate, accountable and secure.

b. The Contractor shall ensure but not limited to performing all necessary calculations in a clear presentation of computations and results in order to facilitate verification by the Contractor himself and by the Engineer of the results arrived at. If any computer simulations have been performed the basis, formulae and the constants adopted shall be indicated justifying their use.

6.9 DESIGN STAGES REQUIREMENTS

6.9.1 The principal requirements of the Design Phase are the production of

- Preliminary Design,
- Detailed Design,
- Construction/Installation Design and
- As Built Documents & drawings.

6.9.2 The Design Phase shall be considered complete upon the issue of a "Notice of No Objection" by the Engineer in respect of the last Detailed Design Submission which shall comprehensively and completely form the Detailed Design for the whole of the Works.

However, the Engineer reserves the right to review and satisfy for adequacy of design, the obligations and intended purpose of the design of the Works in compliance to the Contract.

6.9.3 A conceptual flow of the Design Stages and Review Procedure in the Design and Construction Phases is depicted hereunder :

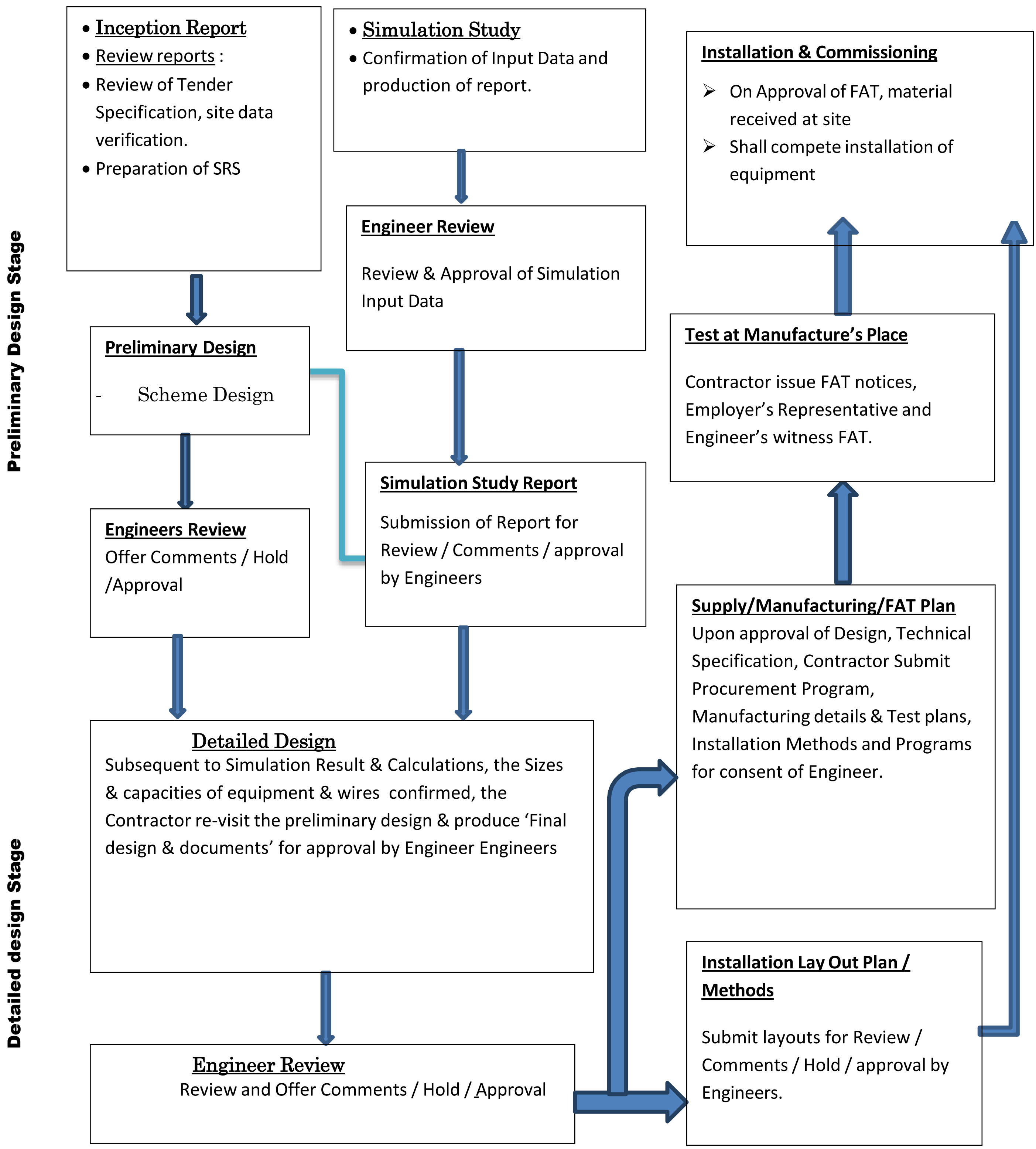


Fig – Design Submissions

6.9.4 Design submissions including Preliminary Design, Detailed Design, Construction / Installation Design, As-Built Documents shall be endorsed with a valid "Design Certificate" as specified.

6.10 INCEPTION REPORT WITH STUDY ON PS, GS AND STANDARDS

6.10.1 Within 42 Days from commencement date, The Contractor shall furnish an Inception Report for approval of the Engineer describing the Project Information, Scope of Work, Project Management Setup, Organization Chart with Key Experts, Project Manager, Communication Matrix, Site office, office for designer, Methodology to deliver identifying the Sub-systems, key activities, key performance parameters, key dates of submissions, document submission program and Initial Work Plan etc.

6.10.2 The Inception Report shall be sufficiently detailed to demonstrate the approach to design for the work under the Scope including but not limited to the main component equipment structures equipment specifications capacities and ratings of major equipment viz. Traction transformers, the Auto transformers, switchgear, conductor sizes their fittings; power supply installation, building required for housing the equipment and SCADA System, Electronic interlocking of major yards and Mobile train communication etc. so that all items necessary to develop the basic component designs and their assemblies, their installation and testing are provided.

6.10.3 The Contractor shall review all applicable data, criteria, standards, directives and information provided to him as the basis for design. Any apparent inconsistencies or erroneous information shall be brought to the attention of the Engineer as a Review Report a part of Inception report. Such information shall not alleviate the Contractor from his responsibilities under the Contract.

6.11 SYSTEM REQUIREMENT SPECIFICATIONS

6.11.1 Within 63 days of Commencement of Work, the Contractor shall prepare a System Requirement Specifications (SRS) as reproduced from PS in sequence as interpolated with Information/ provisions specified in GS, other contract documents or relevant Standard as numbered for each line. SRS will form as a minimum, operational, functional, performance and design requirements of the proposed system.

6.11.2 While the Para number Reference of original document will be retained, the source & Para reference of the content inserted shall also be mentioned in the Document.

6.11.3 The Document may identify or list the deliverables essential for RAM and Safety.

6.11.4 The System Requirement Specifications (SRS), serving as a means of system requirement management and the Contractor's top level design document, shall state all the requirements completely and unambiguously and how each requirement can be verified and validated.

6.12 PRELIMINARY DESIGN

6.12.1 Preliminary Design Stages

a. The preliminary design stage, as a minimum, shall identify the function of each system, sub-system, equipment or other element within the overall SRS and specify the relationships and interfaces between each element of the system including the systems of the interfacing elements of other Contractors.

b. Equipment and interconnection specifications, with supporting calculations, shall be developed at this stage. Submissions shall clarify and confirm as necessary all technical aspects of all interfaces with other elements of contractor's overall design and of any interfaces with systems of other contractors.

c. The Contractor shall submit with each submission a compliance matrix identifying the Cross-references of SRS and submit a Design Verification Table (DVT).

d. Ergonomics of the designed system shall be verified at this stage.

e. Mock-ups/prototypes shall also be developed during this stage.

6.12.2 Preliminary Design Report

a. Within 90 days after the Commencement Date, the Contractor shall submit the Preliminary Design Report as described herein and as further detailed in Employer's Requirements.

b. The Preliminary Design Report shall contain the following but not limited to

   i. Project Information,

   ii. Reproduced the scope of work,

   iii. Environment & Boundary conditions,

   iv. Functional requirement,

   v. Operational & Maintenance requirement,

   vi. Assumptions,

   vii. Design criterion,

   viii. Standards and Reference Documents,

   ix. The System description identifying measure subsystem, equipment and components.

   x. Engineering studies and comparative evaluations on the various systems adopted in past for other projects worldwide with techno economic considerations and recommendations,

   xi. The System's Application Duty Requirement,

   xii. Design Criterion, RAM, safety and life of each components of the Train and input data document essential for Traction Simulation Study to be carried out as per HRIDC's traffic plan of the route.

   xiii. Traction Simulation Study Results for the electrical portion of the work.

c. The Contractor shall submit the Systems & Sub Systems Planning Report to the Engineer for review as part of Preliminary Design Report.

6.13 DESIGN MANUAL FOR SYSTEM WORKS

a. Soon after finalization of rating of components and preparation of Employment schedules required of the Construction Drawings, the contractor shall prepare and submit Design Manual to enable review of the design by the Employer's design team.

b. The Design Manual shall be produced so that it can be used by those involved in the preparation or review of the design of the Works as a comprehensive reference text and efficient working document.

c. The Design Manual shall refer to all material, codes and standards used making clear their specific applications.

d. The Design Manual shall incorporate all design requirements which are relevant to and govern the design including conformance to Standards, codes, Rating, Application Duty requirement, Max temperature, Design Life, Modularity, Redundancy, Reliability, Factors of Safety, Limiting Factors of Electrical Clearances, noise, pollution etc.

6.14 DETAILED DESIGN STAGE

a. During the preparation of the Detailed Design, the Contractor shall in particular ensure that:

   i. All standards and regulations relevant are compiled;

   ii. Complete all Calculations and Analysis;

   iii. The designs meet the application duty requirement;

   iv. Safe design;

   v. The system designs meet the reliability, availability, and maintainability obligations as per best of industry standards;

   vi. All main and other significant elements are delineated;

   vii. All protocol of tests and trials, all selection of material and equipment are complete;

   viii. Assess and take full account of the effect on the Works of the proposed methods of construction, installation, testing and commissioning for permanent and temporary works.

   ix. Complete the validation of all the data provided by the Employer including all the additional surveys, investigations and testing as considered necessary by the Contractor to develop the Detailed Design of the Works in accordance with the Contract.

   x. Draw up a set of the Construction Reference Drawings (CRD) as summarized in Requirements for Submission of Documents and Drawings.

b. Based on the Contractor's Technical proposal and Preliminary Design as consented by the Engineer, the design of the Works shall be fully developed in detail as a part of the 'Detailed Design' by the Contractor.

c. The 'Detailed Design' shall be prepared in accordance with the requirements of :

   i. Train operation requirement as identified in HRIDC's Business Plan & as indicated in the Employer's Requirement;

   ii. Particular Specifications including Design Criteria, Codes, Standards and Manuals as applicable on Indian Railways and applicable regulations / legislation in India and

iii. Existing International norms/standards wherever required.

d. The 'Detailed Design' documents and drawings as developed and updated shall be submitted to the Engineer for consent and issue of a Notice of No Objection.

e. Engineering studies and comparative evaluations shall be performed to ensure that the designs incorporate features to achieve optimum performance in consonance with economy of all elements.

f. The Detailed Design shall include the Construction Reference Drawings, the Works Specification, the Detailed Design Report, the Construction Method Statement and all other contents of the Detailed Design Submittals as summarized in 'Employer's Requirements -- Part 2, Section VII-2: Particular Specifications.

g. The Contractor shall divide the Works into Works Segments in accordance with the "Definition of Works Segments" given in 'Basic Design Philosophy and Requirements for Design' of Employer's Requirements - Particular Specification and shall identify the Works Segments in the Works Program and the Design Submission Program.

h. The Contractor shall sub-divide all the Design into Design Packages which shall be identified in the Design and Certification Submission Program. Each Design Package shall be a clearly and easily identifiable parts of the Design and shall address the design requirements as described herein. The Design Packages shall facilitate the review and understanding of the Design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner to suit the manufacture/supply, installation, testing and commissioning sequence and the Works Program.

i. Separate Design Submissions may be prepared for those major elements to be procured through sub-contract which include design. Where such work is to be procured by the Contractor on the basis of outline design, design briefs and performance specifications, such documents may be submitted as Detailed Design Submissions.

j. Upon completion of Internal Authorization Process, as specified in 'Quality Assurance Requirements' of this Employer's Requirements, the Contractor shall submit the Detailed Design as described herein, to the Engineer for consent and issue of a "Notice of No Objection".

k. Upon issue of the "Notice of No Objection" in respect of the Detailed Design Report, the Contractor shall complete the design in all respects and produce 'Good For Construction Drawings' (GFC).

l. The issue of separate NOCs for such sub-divisions shall be conditional upon the Contractor having demonstrated, to the satisfaction of the Engineer, the adequacy of the ratings of the equipment safety, suitability for application duty including its effects on other Contracts for the whole Works Segment has been fully accommodated in the Detailed Design Package to ensure reliable and safe operations of the completed system.

m. The Contractor shall provide to the Engineer two original full and latest editions of the publications / Technical Standards including the Codes and Standards and other documents that the Contractor proposed to use for carrying out the Detailed Designs, including other communications between Engineer and the

Contractor relevant to this Contract as part of the Inception Report. These publications / documents shall be for the sole use of the Engineer and upon completion of the works shall become the property of the employer.

n. The Temporary Works as essentially needed shall also be identified as a separate Works Segment and the design of those shall be proposed by the Contractor early enough to have sufficient discussions on Engineering and procedural issues with the Engineer so as to meet the intent of the Employer's Requirements. The Contractor shall submit the agreed design of the Temporary Works as part of the Detailed Design to the Engineer for consent.

6.15 DESIGN REQUIREMENTS DURING CONSTRUCTION PHASE

6.15.1 The principal requirements during the Construction Phase are the production, submission and seeking consent of the Engineer for the" Good For Construction" Drawings, Construction Design, the As-Built Documents and the O&M Manuals.

6.15.2 All construction phase drawings and documents shall be revised, upgraded, detailed and integrated in the Construction Design Package.

6.15.3 The Contractor shall fully verify and endorse all Drawings and documents with Design Certificate during Construction Design Package through the Internal Authorization Process as specified*.*

6.15.4 Construction Design

a. The Construction Phase for the whole or a part of the Works shall commence immediately upon the issue by the Engineer of a 'Notice of No Objection' in respect of the relevant Detailed Design Submission, subject to the availability of the Site in accordance with the agreed Program for site hand over by the Employer. Such "Notice of No Objection" may be issued by the Engineer in respect of a Detailed Design Submission covering a major/ distinctive part of the Works/ activity in accordance with the Design Submission Program. However, construction shall not be commenced until the appropriate Construction Reference Drawings and other documents forming the Construction Design Package have been endorsed as "Request for Construction" through the Contractor's Internal Authorizing and Quality Assurance Process.

b. The Construction stage drawings shall be coherent and complete set of Document in line with the preliminary Design Document along with a copy of the NOC issued previously by the Engineer for the relevant portion, shall be submitted to the Engineer. The detailed design reference shall also be incorporated in such submissions

c. Detailed Design Drawings shall form part of the Drawings to be used for installation purposes and construction shall be strictly in accordance with the relevant Design Stage.

d. Only those drawings and documents that have been endorsed and certified and have received consent as above shall be issued to the Site

e. The Construction Phase shall include the completion and submission of the Construction/Installation Design and the As-Built Documents

f. The design of the permanent and temporary works of this contract shall be carried out in accordance with the Contractor's Quality Assurance Plan in compliance with the Employer's Requirements.

g. the Contractor shall produce the respective Construction Design Package which shall include, but not limited to,

   i. The 'Good For Construction Drawings',
   ii. Updated construction stage related Project Management Plans;
   iii. The updated Works & Material Specifications;
   iv. Updated Technical Drawings;
   v. Updated detailed design Report;
   vi. Method Statements/ work procedures/ construction sequences;
   vii. The Interface Drawings related to the other Construct Contracts;
   viii. Field change Drawing & Design, if any.

h The Good for Construction Drawings and Construction Reference documents shall include site sketches, dimensioned drawing, fabrication and shop drawings, erection plan and sequences etc.

i Construction stage related Project Management Plans as detailed this GS and Particular Specification shall be updated and endorsed by the Contractor through the Contractor's Internal Authorizing Process as being in accordance with the Technical Design for which the Contractor has received the "Notice of No Objection".

j Construction stage Works & Material Specifications as detailed in this GS and Particular Specification shall be updated and be endorsed by the Contractor through the Contractor's Internal Authorizing Process as being in accordance with the Technical Design for which the Contractor has received the "Notice of No Objection".

k The Construction Design and Construction Technical Drawings including updated Works Specifications / Method Statements etc. shall be derived directly from the Detailed Design as approved by the Engineer including the incorporated changes as commented by the Engineer attached to the Notice of No Objection.

l The Working/ Fabrication Drawings and the Construction Practicing Documents shall be prepared to facilitate construction to meet the required workmanship as well as technical requirements.

m The updated Method statements shall be prepared to check and monitor the Works in terms of SHE requirements described in Project SHE Manual and Quality Assurance.

n Upon the Internal Authorization Process, the Contractor shall submit the Construction Design Package as the "Request for Construction" to the Engineer for consent and issue of a Notice of No Objection. Upon receipt of the "Notice of No Objection" or "Notice of No Objection With Comments", the Contractor shall endorse the original paper drawings in respect of the Working Drawings as "Good For Construction" as per the Internal Authorization Process and issue.

o If the Engineer so requires, the said endorsed original paper drawings shall be re-submitted to the Engineer, who shall, if has no objection to the contents of the re-submission, further endorse the original paper drawings by stating that he has no objection to the proposed Working Drawings. On endorsement by the Engineer, the original drawings will forthwith be returned to the Contractor as Working Drawings to be issued to Site.

p The "Good For Construction Drawings" and the Working Drawings shall be used for construction purposes and only those drawings and documents that have been endorsed and certified through the procedure and have received "Notice of No Objection" as above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site.

q The Construction of the Works shall be strictly in accordance with the Construction Design Package, for which "Notice of No Objection" has been issued by the Engineer and "Good For Construction" drawings has been issued as per the authorization process detailed as above.

r The Construction Design Package may be divided into multiple submissions for different Work Segments as required to be consented by the Engineer. In such a case:

i. Construction Design and Drawings in respect of each Work Segment shall be submitted for the entire scope of work.

ii. All Submittals which are commonly applicable to the subsequent submissions shall be submitted in the initial submission and each submission shall include correlated and interdependent submittals.

iii. All the divided Construction Design Submissions shall be integrated and compiled into one package at the time when the final submission is made as the Construction Design Package.

s If the Contractor identifies the need for any change to the design due to site conditions or any other reason, the Contractor shall produce a Design Change Notice or Field Change Notice in accordance with procedures as specified.

t The Contractor shall submit the Construction Design and Drawings for a particular work to the Engineer at least 3 months but not more than 6 months prior to the planned / scheduled date of commencement of that particular work.

6.15.5 Design Changes And Variation Procedure

a. Design Changes

In the event that the Contractor identified a problem or other cause for a change in his design after the Construction Design has been submitted and consented by the issue of Notice of No Objection during the Construction Phase, the Contractor shall propose, in writing the design change through, a solution and procedure either a Field Change Notice (FCN) or a Design Change Notice (DCN) or a Variation Notice (VN) depending on the severity of the change within the Contract.

A major design shall warrant a Design Change Notice and These Design changes shall go through the full process of the Design Review Procedure. Whenever site changes may be agreed at site level by producing a Field Change Notice, the Engineer shall decide whether the proposal shall be DCN or FCN.

b. Design Variation

Design Variation including Value Engineering may be initiated at any time prior to issuing the Taking-over Certificate for the Works. A design variation shall not result in the omission of any of the Works.

6.16 AS-BUILT DOCUMENTS

6.16.1 The Contractor shall maintain all records necessary for the preparation of As-Built Documents. The Contractor shall prepare and submit As-Built Drawings and the Records which shall become the contents of As-Built Documents on Engineer's agreement. Within seven days of commissioning of any Sub-System, the Contractor shall submit 6 sets of verified design documents. Prior to the issue of the Taking-Over Certificate and in accordance with the Conditions of Contract Clause 5, the Contractor shall prepare As- Built Drawings and Records which, subject to the Engineer's agreement, shall become the contents of As-Built Documents.

6.16.2 As-Built Drawings shall be a full set of the latest revisions of the Construction Technical Drawings, which are updated to incorporate all variation orders, Design Change Notices and Field Change Notices as well as Working Drawings as necessary to convey a full and true record of the as-built condition of the Works. As-Built Drawings shall show all changes from the Preliminary/Final Detailed/Construction Designs and Drawings, all construction deviations and all other features relevant to the future maintenance and management of the Railway and its facilities.

6.16.3 As-Built Drawings shall be endorsed by the Contractor as true records of the constructed Works.

6.16.4 As-Built Records shall include the recorded photographs as being consistent to Progress Reports in the Conditions of Contract.

6.16.5 As-Built Records shall be verified and endorsed by the Contractor through the Internal Authorization Process, as specified in 'Quality Assurance' of this Employer's Requirements, as true records of the construction of the Works.

6.16.6 As part of the As Built Documents, the Contractor shall maintain all records necessary for the completion and commissioning of the project. These records shall consist of as a minimum but not limited to the following:

a. The list of implemented work according to activities, locations/ places;

b. Used Material – type, Name of Material, name of manufacturers along with batch number, Date of Manufacturing, locations/ places and quantities etc;

c. Installation drawing complete with route, location plan, Mounting details and cross sections of Equipment & Components;

d. 'Control' and 'Status' monitoring Cable index, control logics, schematics and wiring diagrams as applicable';

e. Electrical and mechanical clearances including Clearance of track side equipment (e.g. OHE mast, Signals, Location Boxes etc.) in millimeters from Centre line of adjacent track(s) shall be verified and painted on the relevant equipment;

f. Any other record as required by the Engineer / Employer;

g. Records related with acceptance of change orders and

h. Construction Diary.

6.16.7 The Contractor shall prepare and submit the Operation and Maintenance Manuals (O&M Manuals) as part of the As-Built Documents.

6.16.8 The O&M Manual shall include the details of each system, subsystem, equipment / components of the Work as essential along with performance benchmarks of reliability, availability and Maintainability. The Requirement for the Operation and Maintenance Manuals (O&M Manuals) is further detailed in the this GS under different section in accordance with the Specifications and in sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair the Works.

6.16.9 The As-Built Documents shall be submitted to the Engineer for consent and issue of a "Notice of No Objection".

6.16.10 All the As Built Drawings and Records shall be submitted prior to the commencement of the Trial Runs. If as a result of tests and trials the "As built Drawings" need to be revised, these shall be also carried out. The Work shall not be considered to be completed for the purposes of issue of "Taking over Certificate" until these documents and manuals have been submitted and accepted by the Engineer.

6.17 DESIGN INTERFACE WITH OTHER CONTRACTORS

6.17.1 Other Contractors

(1) The Contractor shall fully coordinate the design of the Works with the design of the other Contractors and shall follow the interfacing requirements as detailed in 'Interface Matrix'.

(2) Those Works, which are required to be executed by the Other Contractors, shall be fully coordinated and integrated and shall be provided throughout the Design development and the results shall be recorded and summarized in the Combined Service Drawings (CSD) and the Interface Drawings and Report on Other Contractors as part of the Detailed Design.

6.17.2 External Related Parties

(1) The Contractor shall fully coordinate the design of the Works with all relevant bodies and entities, in particular government authorities, departments and regulatory bodies, public utility companies, Power Supply Authorities, Indian Railway, consultants and contractors of adjacent projects whether ongoing or planned, as advised by the Engineer. The Contractor shall identify all such related parties in his Interface Management Plan (IMP) and other relevant requirements detailed the Particular Specification to the Employer's Requirements.

(2) Co-ordination with Indian Railways for HRIDC's General arrangement of OHE layout and their proposed Design in respect of those in vicinity of the existing structures of Indian Railways shall also be required to get approval from Indian Railways through Employer in addition to the consent by the Engineer. The Contractor shall be required to submit one additional copy of all his GADs / span arrangement and Design of all such structures to the Engineer for onward submission to Indian Railways.

(3) The Employer shall co-ordinate seeking the approval from Indian Railways, however, the Contractor shall facilitate the Engineer / Employer in seeking the approval from Indian Railways including but not limited to providing

clarifications / additional data, attending meetings etc. as required.

6.18 DESIGN SUBMISSION PROCEDURE

6.18.1 In the case of submissions subsequent to the Technical Design, the Design Data shall be in accordance with the Employer's Requirements and the Technical Design.

6.18.2 The Contractor shall submit to the Engineer all the Designs and relevant Design Data together with the Design Certificates, on or before the respective dates for submission shown on the Design Submission Program or the Works Program detailed in Chapter-4 of this document. In the event that a resubmission of Design / Design Data is required, such resubmission shall be made as soon as practicable after the receipt of the relevant statement of objections. All submissions of Design Data shall include the copies as stipulated in the Employer's Requirements.

6.18.3 Following receipt of a submission of Design and Design Data, the Engineer shall, within the period specified in Design Submission Program respond as per the procedure defined therein and issue "Notice of No Objection" or "Notice of No Objection with Comments" or "Notice of Objection with Comments" as the case may be. The Contractor shall comply with the requirements accordingly as specified therein.

6.18.4 The issue of a 'Notice of No Objection' in relation to any submission of Design shall be entirely without prejudice to the review of subsequent submissions of Design or to any subsequent request for a Contractor's Variation, and shall not bind the Engineer in any manner Dedicated whatsoever when deciding whether to accept or not to accept the issue.

6.18.5 The Contractor shall obtain all required and /or statutory approvals, prior to the submission of all Design and shall ensure that all required approvals have been obtained.

6.19 DESIGN REVIEW PROCEDURES

a. The designs for all stages shall be submitted for review and consent to the Engineer. The form and the procedures adopted in the Contract shall not release/remove/ exonerate the Contractor's responsibility towards the design under this contract.

b. The issue of a 'Notice of No Objection' will be without prejudice to the issue of any future Notices.

c. Supplemental, supporting information to the design submission under review may be requested by the Engineer. The Contractor shall supply such information within the time specified by the Engineer.

d. All submissions shall be accompanied by six (6) original copies of "Design Certificate" format as per Appendix-3.

6.20 DOCUMENT & DRAWINGS SUBMISSION PROCEDURE

The Contractor's Technical Proposals shall be amplified during the design stages. The following process of document submission shall be generally followed:

a. The Contractor shall submit drawings and documents, as required by the Contract, to the Engineer in accordance with the Design Submission Program meeting the requirements.

b. The Construction Design submittals shall be made sufficiently before the Works are to be carried out to give the Engineer reasonable time to examine the drawings or other documents and to prepare comments within the response time.

c. Where the consent / Notice of No Objection from the Engineer is required, the Engineer shall notify the Contractor in writing of his decision within stipulated time of 28- days.

d. the Engineer has reasonable cause for being dissatisfied with the submissions made by the Contractor, the Engineer shall inform the Contractor in writing to make such amendments thereto as the Engineer may considerer necessary. The Contractor shall make such amendments at no additional expense to the Employer and shall resubmit the amended documents for Engineer's consent.

e. Within 7 days of notification of the Engineer's consent / "Notice of No Objection" or "Notice of No Objection with Comments", the Contractor shall provide the Engineer with the type and numbers of sets of the relevant drawings and / or documents as stipulated in the Employer's Requirements for further execution of the process.

f. Should it be found at any time after notification of consent / "Notice of No Objection" / "Notice of No objection with Comments" (as the case may be) that the relevant drawings or documents do not comply with the Contract or do not agree with drawings or documents in relation to which the Engineer has previously notified his consent / "Notice of No Objection" / "Notice of No objection with Comments" (as the case may be), the Contractor shall, at his own expense, make such alterations or additions as, in the opinion of the Engineer, are necessary to remedy such non-compliance or non-agreement and shall submit all such varied or amended drawings or documents for the consent of the Engineer.

g. Errors, omissions, ambiguities, inconsistencies, inadequacies and other defects shall be rectified by the Contractor at his own cost and the acceptance by the Engineer of the Manufacture and Construction Documents shall not amount to any waiver and shall not relieve the Contractor of his obligations under the Contract.

h. No examination by the Engineer of the drawings and / or documents submitted by the Contractor, nor any consent / "Notice of No Objection" / "Notice of No objection with Comments" (as the case may be) of the Engineer in relation to the same, with or without amendment, shall absolve the Contractor from any of his obligations under the Contract or any liability for or arising from such drawings or documents.

6.21 CALCULATIONS

6.21.1 The contractor shall submit all the drawings accompanied with Detailed report, calculations, supportive documents, references and evidences of previous examples where in such a method has been used.

6.21.2 All the required calculations shall be submitted together with the respective Design

Package submissions unless stated otherwise.

6.21.3 A comprehensive set of calculations for the whole of the Design including that for simulation study in the form acceptable to the Engineer shall be submitted by the Contractor to the Engineer for consent as part of the relevant submittals.

6.21.4 Should the design of the Works be revised, the Contractor shall prepare and submit revised calculations as well as the revised designs and drawings and recall all previous versions circulated in past.

6.21.5 The Engineer shall require the Contractor to submit and install one copy of all the applicable software as used by the Contractor for the Design excluding the train and traction Power Simulation Computer Program, duly licensed in the name of Employer and the Engineer and in accordance with Employer's Requirements of this specification including in-house software program / worksheets developed by the Contractor, computer input and program logic prior to the acceptance of any computer output. The Contractor shall submit the same to the Engineer without any additional cost.

6.21.6 Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

6.22 CONTRACTOR'S WARRANTY OF DESIGN

6.22.1 The Contractor warrants that the Contractor's design shall be in accordance with General Obligations Conditions of Contract and meets the Employer's Requirements and Specifications provided by the Employer and is fit for the purpose thereof. Where there is any inadequacy, insufficiency, impracticality or unsuitability in or of the Employer's Requirements and Specification or any part thereof, the Contractor's design shall take into account, address or rectify such inadequacy, insufficiency, impracticality or unsuitability at Contractor's own cost.

6.22.2 The Contractor shall indemnify the Employer against any damage, expense, liability, loss or claim, which the Employer might incur, sustain or be subject to arising from any breach of the Contractor's design responsibility and /or warranty.

6.22.3 The Contractor further specifies and is deemed to have checked and accepted full responsibility for the Contractor's part of the design notwithstanding:

a. That such design may be or have been prepared, developed or issued by the Employer which has been checked by the Contractor, any of Contractor's consultants, his sub contractor's and/or his qualified personnel/persons or cause to be prepared, developed or issued by others.

b. Any warranties, guaranties and /or indemnities that may be or may have been submitted by any other person.

c. That the same have been accepted by the Engineer.

6.22.4 The Contractor shall conform to the provision of any statute relating to the Works and regulation and bye-laws of any local authority and of any water and lighting agencies or undertakings, with whose system the work is proposed to be connected and shall before making any variation from the drawings or the specifications that may be necessitated by so confirming give to the Engineer notice specifying the variation proposed to be made and the reason for making the variation and shall not carry out such variation until he has received instructions from the Engineer in respect thereof. The Contractor shall be bound to give all notices required by statute, regulations or bye-laws as aforesaid and shall pay all fees and taxes payable to any authority in respect thereof. Nothing shall be payable by the Employer in this regard.

6.22.5 The Contractor shall ensure compliance of provision of all laws of land in force and enacted from time to time and ensure compliance of the regulations or bye-laws of any local body and utilities. The ignorance of rules, regulations and bye-laws shall not constitute a basis for any claim at any stage of work. The Contractor shall arrange necessary clearances and approvals before the work is taken up.

6.22.6 The Design Warranty shall be submitted by the Contractor in format provided at Chapter 15: Annexure 3 – Design Certificate of this GS.

(End of Chapter 6)

CHAPTER 7 - WORK AREA MANAGEMENT

7.1 WORKS AREA

7.1.1 The Contractor shall divide the Site into separate Works Areas/Railway Envelopes and shall elaborate a schedule for the time periods of the availability of these areas for his contract performance. This should be synchronized with the Schedule of access to Site provided in Section IX: Part A – Contract Data of Particular Conditions of Contract (PCC), Part 3 of Tender document of the Bidding documents taking account of the Contractor's co-ordination and integration responsibilities with the interfacing contractors.

7.1.2 The Contractor shall indicate the exact nature of the various Works Areas and the extent of works to be carried out prior to the execution of the permanent systems works or making use of the area as working space and/or for temporary Site facilities.

7.1.3 The schedule as mentioned above shall include, but not limited to, the following data:

(1) Indication of the Works Areas;

(2) Description and intended use of the Works Areas;

(3) The start and the end date of the availability of the Works Areas, required by the Contractor;

(4) The start and the end date of the periods in which the Contractor is to allow the Works Areas to be accessed by interfacing parties.

7.1.4 The information shall be submitted as part of the Contractor's preliminary design and shall be subject to agreement by the Employer and approval by the Engineer.

7.1.5 On the basis of the approved information, the Contractor shall submit the proposal for the use and the occupation of the Works Areas, such submissions being at least fifty six (56) days prior to the program use of the specific Works Area.

7.1.6 Prior to the scheduled dates for returning of any of the Works Areas for subsequent use by an interfacing party, the Contractor shall carry out the following activities:

(1) Construct all Permanent Works within the Works Area, to the extent as defined in the Detailed Design and in accordance with the requirements of the Contract;

(2) Reinstate the area to the same condition as it was taken over;

(3) Form the area to the approved lines and levels and carry out such other works as may be required by the provisions of the Contract;

(4) Remove all rubbish, debris and other material; and

(5) Carry out and record jointly with the Engineer and interfacing contractors a condition survey of the area.

7.1.7 Restrictions on the timing of occupation so as to avoid affecting operation will be made.

7.1.8 The interfacing parties shall be required to vacate the Works Areas at least 28 days before the due date for handing over back of the Works Areas by the Contractor to the Employer, thus allowing the Contractor to clear and reinstate the works areas in accordance with the Contract.

7.1.9 Entry to and exit from the Site shall be controlled and shall be only available at the locations for which the Engineer has given his consent.

7.1.10 The Contractor shall ensure that access to every portion of the Site is continually available to the Employer and Engineer.

7.1.11 Other contractors engaged for project execution shall also be allowed to use the temporary facilities so created by him to access the Site without any consideration.

7.1.12 Employer will take over the entire stretch as per General Conditions of Contract.

7.1.13 The Contractor shall be responsible for ensuring that any access or egress through the Site boundaries are controlled such that no disturbance to residents or damage to public or private property takes place as a result of use of such access or egress by its employees and sub-contractors.

7.2 STANDARD ENGINEERING CONDITIONS

The following standard engineering conditions apply to all Works Areas:

7.2.1 Forming of Areas

(1) The Works Areas shall be formed to the levels shown on the drawings. No levels shall be amended without prior consent of the Engineer.

(2) The Works Areas shall be surfaced in a manner agreed with the Engineer, compatible with their intended use and in particular, footpaths and roadways connecting facilities shall be provided.

(3) Measures shall be taken to the satisfaction of the Engineer to ensure all areas are properly drained and kept free of static water.

7.2.2 Roads and Parking

(1) Space shall be provided within the Works Areas for parking, loading/unloading and maneuvering of motor vehicles.

(2) Any damage caused by the Contractor to the adjoining public roads and fixtures and properties (public or private) shall be made good to the satisfaction of the Engineer and its owner.

7.2.3 Drainage and Sewerage

(1) All storm or rainwater from the Work Areas including any access roads thereto shall be carried to the nearest stream course, which has the necessary capacity, catch-pit, and channel or storm water.

(2) All temporary and permanent Works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the Site and adjacent property.

(3) Damage or obstruction caused to any watercourse, drain, main or other water installations within or adjoining the Works Areas shall be made good to the satisfaction of the Engineer.

(4) Treatment and disposal of sewage and wastewater from the Works Area shall be provided to the satisfaction of the Engineer following the ecological requirements.

7.2.4 Buildings

(1) No permanent structures other than those required for the Permanent Works shall be permitted in the Works Areas.

(2) The Contractor, as required, for all temporary buildings, shall provide requisite electricity, water, telephones and sewerage facilities.

7.2.5 Pedestrian Access

Any accesses or passing through the Works Areas shall be maintained in a usable condition at all times to the satisfaction of the Engineer including lighting, signing and guarding.

7.2.6 Fencing and Signboards

For executing the work adjacent to running traffic areas, the Contractor shall erect fences and gates around its areas of operations to prevent accidents as well as post competent flagmen.

7.3 POSSESSION OF IR TRACKS

7.3.1 General

(1) The Contractor shall comply with the traffic block (Possession) management system operated by Indian Railways (IR).

(2) The person appointed by Contractor shall coordinate with IR and the CST Contractors and shall act as the traffic block coordinator for the Contractor.

(3) The person appointed must have experience of IR operations and must be fully aware of IR rules and regulations related to possession of track for construction of railway works in accordance with IR regulations including meeting the Competency requirements as stipulated by IR.

7.4 POSSESSION PERIODS

(1) The Contractor may use possession(s) on the line for execution of works as per approved plan following strict safety procedures.

(2) Line closures may be agreed subject to IR approval.

(3) The Employer gives no warranty that line closures and possession periods will be available during the period of the Works.

(4) The Employer will however provide any assistance necessary to the Contractor to enable him to obtain the line closures and possessions required by him for the Works but will not be responsible if any Possession requests are refused by IR.

(5) The Contractor shall prepare technological and organizational schedule for construction which shall include the work times in the weekends and during the dark part of the day.

(6) The Contractor shall submit his requests for 'possessions' at least fourteen (14) days earlier and inform IR at least 48 hours earlier if he is not able to use the permitted 'possessions'.

7.5 TEMPORARY WORKS

The Temporary works are detailed in Appendix—4.

7.6 REQUIREMENT FOR CONSTRUCTION

The Requirements for Construction are detailed in Appendix-5.

(End of Chapter 7)

CHAPTER 8 - SUPPLY, INSTALLATION, TESTING & COMMISSIONING

8. 1 GENERAL

8.1. 1 These Employer's Requirements establish the overall procedure for the Contractor to follow for the Works that is related to the components manufactured off-site and supplied for installation in the Permanent Works. These requirements relate to their manufacturing, procurement, delivery, testing and installation in the system and associated activities.

8.1. 2 The Contractor shall establish procedures and controls that govern the procurement/manufacturing off-site of material/equipment/ components required for the work and supply them for construction/installation, assembling and wiring in the Permanent Works.

8.1. 3 The Contractor shall submit a comprehensive Testing Plan & Program for the project to the Engineer for his consent.

8.1. 4 Type Test shall be performed by the Contractor and shall be witnessed by Employer's Personnel/Representative and / or the Engineer.

8.1. 5 Factory Acceptance Test including stage inspection if required shall be performed by the Contractor and shall be witnessed by Employer's Personnel/Representative and/ or the Engineer.

8.1. 6 Approval for witnessing Type Test shall be communicated by the Engineer to the Contractor after obtaining consent from the Employer.

8.1. 7 The material delivered to the Site and offered for Inspection shall be manufactured normally not earlier than one (1) year and their guarantee period shall cover the Defects Notification Period. However, the specified period of Manufacturer's Warranty shall commence from the date of commissioning of the Work and all the manufacturer's Warranties shall be in the name of the Employer.

8.1. 8 All material used for permanent work shall be as per the Specifications (SRS) and SOGP as approved by the Engineer.

8.1. 9 Manufacturing and testing of various equipment, components and fittings shall be as per approved Technical requirement, SOGP etc.

8.2 MANUFACTURING

8.2.1 Management

The Contractor shall establish procedures and controls that govern the procurement, integration, manufacturing and testing, quality assurance and delivery of plant & equipment, manufactured items and spares to be supplied under the Contract. The Contractor shall submit Procurement Management & Manufacturing Plan and Quality Assurance Plan to the Engineer for his consent.

8.2.2 Procurement and Subcontract Management

The Contractor's Management Systems and Procedures shall incorporate procedures for material procurement and sub-contracting, sufficient to assure technical, administrative, quality and contractual controls consistent with those under this contract. The

Contractor's management system shall be auditable for material sources, lot numbers, serialized equipment, etc. Sub-contract amendments shall be effected whenever contractual changes are made bi-laterally by the parties involved subject to consent of the Engineer.

8.2.3 Manufacturing Management

The Contractor's Quality Assurance Plan to control the Manufacturing quality shall contain:

(1) A brief description of all inspection & Hold points and test points in correlation with the Program Schedule;

(2) A list of all manufacturers, and sub-contractors for supply.

(3) A delivery schedule of each item of equipment to match installation plan.

8.3 TESTING

A comprehensive Testing Program submitted by the Contractor shall include complete equipment, their subsystems and components and material to ensure conformance with the specifications. The Testing Program shall be subject to the consent of the Engineer. The purpose of the comprehensive Testing Program shall be to:

(1) Substantiate design and performance characteristics;

(2) Ensure operational compatibility;

(3) Complete equipment verification and acceptance requirements; and

(4) Complete all reliability, maintainability and safety demonstration requirements.

(5) Testing shall comply with the requirements as specified in this Employer's Requirements

Unless otherwise agreed, all tests shall be witnessed by Employer's Personnel/Representative and / or the Engineer & recorded. An appropriate format for Test Schedule(s) and Procedure(s) including the details of testing equipment shall be submitted to the Engineer for approval. All tools & instruments for carrying out the tests shall be arranged by the Contractor to the satisfaction of the Engineer. Test results will be witnessed and signed by the Contractor and the Engineer and/or Employer's Personnel/Representative.

8.4 QUALITY ASSURANCE AND CONTROLS

8.4.1 The Contractor's management systems shall emphasize quality assurance and controls and shall be based on ISO 9001-2008 standards. The Procurement**,** supply and manufacturing and Quality Assurance Plan together with the Comprehensive Testing Program shall adequately ensure an acceptable level of quality of the Items manufactured and supplied. The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of the Contractor's organization shall be evidenced by:

a. Producible and verifiable designs;

b. Firm procurement and job performance specifications;

c. Firm procedures for transmission of information and data to sub-contractors and ensuring their compliance;

d. Adequate testing to ensure repetitive product conformity to design requirements; and

e. Total Program of surveillance and verification of physical performance and configuration accountability.

8.4.2 The Contractor shall maintain records to demonstrate evidence of quality and accountability. These records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant material and other quality control requirements.

8.4.3 Inspecting and testing records shall be in ISO format and as a minimum, indicate the nature of the observations made, the number & types of deficiencies found and action proposed to correct deficiencies. Also, records for monitoring work performance and for inspecting and testing shall indicate action taken for the correction of deficiencies.

8.4.4 The Contractor shall submit to the Engineer a request for a "Notice of No Objection to Supply" for the manufactured items along with all the relevant manufacturer's test certificates and inspection certificates prior to shipping / transporting. However, the material which have been inspected and the testing of which has already been witnessed by the Employer's representative, the "Notice of No Objection to Supply" may be issued directly by the Employer's representative.

8.5 PACKAGING, TRANSPORTATION AND STORAGE OF PLANT AND MATERIAL

8.5.1 Packaging and Shipping

(1) The packaging and shipping shall be done keeping in mind that the equipment and cables do not get damaged during transit. The Contractor's quality control personnel shall verify the inspection and preparation for shipment.

(2) Each case, crate or package shall be of robust construction and suitable for the intended purpose. Packaging material that are likely to suffer deterioration in quality as a result of exposure to environmental conditions likely to be met during transit from the factory of origin to the Site shall not be used.

(3) Each case, crate or package shall be legibly and indelibly marked in large letters with the address, Contract number, 'right way up', opening points and other markings like "fragile", "keep dry", "handle with care" etc. along with visual display of internationally accepted symbols as necessary to permit material to be readily identified and handled during transit and when received at Site.

(4) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents together with any relevant drawings. A second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the requirements of the Engineer.

(5) Care shall be taken to prevent movement of equipment within containers by the provision of bracing, straps and securing bolts as necessary.

(6) Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped.

(7) Spare parts shall be suitably packed for storage over an indefinite period without deterioration and shall be clearly identified showing full name and part number

without any need to unwrap packaging. Electrical and other delicate items or equipment shall be cocooned.

(8) Cable ends, cable entry points into equipment and other similar terminations and openings shall be sealed or blanked off to prevent the ingress of dirt, vermin or moisture.

(9) Tube ends and other similar openings shall be thoroughly cleaned and then blanked-off to prevent ingress of dirt or moisture.

(10) Particular care shall be taken to prevent damage to or corrosion of shafts and journals, where they rest on timber or other supports that may contain moisture.

(11) At such points wrappings impregnated with anti-rusting compositions shall be used, of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

(12) Care shall be taken to minimize risk of damage to ball and roller bearings and any fragile material in transit.

8.5.2 Cable Drums

(1) Immediately after the tests at the place of manufacturing, both ends of every length of cables shall be sealed by enclosing them with approved caps, tight fitting and adequately secured to prevent ingress of moisture.

(2) The ends of the factory lengths of cable shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers is clockwise and "Z" the end at which the sequence is anti-clockwise.

(3) The end which is left projecting from the drum shall be consistently "A" or "Z", and shall be protected against damage in such a manner that the enclosure cannot be easily removed during handling while in transit.

(4) Cables shall be supplied on drums in the longest possible lengths and within practical limits.

(5) The maximum allowable diameter of cable drum shall be 2000 mm. The use of cable drums with diameter in excess of 2000 mm shall be subjected to the review of the Engineer.

(6) The drums shall also be designed for use in conjunction with any special cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

(7) Each drum shall bear a distinguishing number and label "HRIDCL", either printed or neatly chiselled on the outside of a flange.

(8) Particulars of the cable, i.e. voltage, length, conductor size, number of cores, section and length, gross and net weights, shall be clearly shown on one flange of the drum.

(9) An arrow showing direction of rolling shall be shown. Both ends of the cables shall have heat shrinkable caps. The caps shall incorporate sealants which melt on heating at temperatures well above outdoor ambient expected in DFCC area.

8.5.3 Handling, Storage and Delivery

(1) The Contractor shall ensure Comprehensive Test and inspection instructions for handling, shipping, storage, preserving, packaging, packing, marking, and shipping to protect the quality of the equipment and to prevent damage, loss,

deterioration, degradation or substitution thereof.

(2) Handling procedures shall include the use of special crates, boxes, containers, transportation vehicles, equipment and facilities for material handling.

(3) Unless otherwise consented by the Engineer, the Contractor shall provide adequate and covered storage facilities for storing in a safe and secure manner all the plant & equipment and manufactured items to be supplied and erected as part of the Contract.

(4) The Contractor shall make its own arrangement of space for storage facility. However, if the spare land is available with the Employer, the same will be handed over to the Contractor free of cost, for the purpose of establishing temporary construction depot(s) with the condition that whenever the Employer requires this portion of land back, the same shall be handed over by the contractor at a month's notice at no extra cost/compensation to the Contractor.

(5) Means shall be provided by the Contractor for protection against deterioration or damage to equipment in storage. Where shelf-life of the equipment / material is limited, this shall be clearly stated on the shipment. Secure compound and storage for the high value items shall be integral part of the safe storage. Spares to be supplied shall also be kept safe and secure until handed over to the Employer at the time of Commissioning.

(6) The Contractor shall include the delivery activities in his Monthly Schedule Updates that he would submit to the Engineer in accordance with provisions of Chapter 3 of this GS.

(7) The Contractor shall ensure the Site is ready and in good conditions for delivery.

(8) The Contractor shall remove temporary fittings, if necessary, for delivery of his items to site and shall restore the fittings to the original state and to the satisfaction of the Engineer.

(9) No dangerous goods shall be delivered to the Site.

8.5.4 General Precautions

(1) Spare parts shall be suitably packed for storage over an indefinite period without deterioration and shall be clearly identified showing full name and part number without any need to unwrap packaging. Electrical and other delicate items or equipment shall be cocooned.

(2) Cable ends, cable entry points into equipment and other similar terminations and openings shall be sealed or blanked off to prevent the ingress of dirt, vermin or moisture.

(3) Tube ends and other similar openings shall be thoroughly cleaned and then blanked-off to prevent ingress of dirt or moisture.

8. 6 INSTALLATION

8.6.1 The Contractor shall carry out site surveys to ensure sufficient knowledge of the Site before submitting the relevant installation drawings and installation related submissions to the Engineer for review.

8.6.2 The Contractor shall provide all necessary and sufficient resources such as tools, test instruments, spares, and equipment, manpower and communication facilities to complete all the installation activities.

8.6.3 The Contractor shall ensure that all Installation works are supervised and technical, safety and quality matters adhere to the Design as reviewed by the Engineer.

8.6.4 The Contractor shall take every precaution to protect existing equipment and facilities on Site from damage and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment(s).

8.6.5 During installation, care may be taken to ensure that the manufacturer's erection instructions are correctly followed.

8.6.6 The installation for major items such as important components and vital equipment shall be undertaken preferably in the presence of the manufacturer's field service representative.

8.6.7 All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Engineer.

8.6.8 The Contractor shall ensure that his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

8.6.9 The Contractor shall assign competent site supervisors for each work site to be responsible for all site-related matters.

8.6.10 The Contractor shall carry out regular site audit on both technical and safety matters and maintain records of the site audits. The Contractor shall make these records available to the Engineer for inspection upon request.

8.6.11 All the equipment shall be installed in accordance with OEM's installation checklist. A certificate shall also be required to be issued by the OEM that the installation has been done in accordance with the Installation checklist and Earthing and surge protection arrangements are in accordance with latest RDSO specification. The equipment shall not be commissioned unless such a certificate has been issued by the OEM.

8.7 INSTALLATION METHOD STATEMENT

8.7.1 Installation Method Statements which is part of the Construction/Installation Method Statement shall be submitted to the Engineer for review at least 28 days prior to the installation activity commencing on site.

8.7.2 The installation method statement shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.

8.7.3 Prior to proceeding with installation, the Contractor shall submit, for the Engineer's consent, six copies of drawings showing all installations including dimensions, supports, hardware, installation methods and documents confirming the availability and location of special installation tools and equipment and all other pertinent data.

8.7.4 The Contractor shall make certain that the installation of all supports, gaskets, hardware, etc., are accomplished so as to assure safe, accurate and trouble-free installation. The installation for major items such as important components and vital equipment such as Traction and Auto transformers shall be undertaken preferably in the presence of the manufacturer's field service representative.

8.7.5 Upon noticing or being advised of any inconsistencies between the installation drawings and documentation and the installed equipment, the Contractor shall notify his acknowledgement to the Engineer and correct such errors within two weeks.

8.7.6 Equipment that is improperly installed shall be removed, checked / tested and reinstalled.

Any damage caused due to improper installation and removal shall be rectified before reinstallation at no extra cost to the Employer.

8.8 MATERIALS AND WORKMANSHIP

8.8.1 Materials utilized in the Works shall be free from defects, shall be new, recently manufactured and of a classification and grade in full conformity with the Contract.

8.8.2 Products and equipment shall be approved only when the Engineer has been satisfied as to their strength, reliability and suitability as per application duty requirement. To assist the Engineer in this respect, the Contractor shall furnish on request, performance data, references to completed works and any other relevant information together with samples of materials for approval. Materials and any other articles adopted without the approval of the Engineer shall be rejected.

8.8.3 The Works shall be constructed in accordance with the Good Industry Practice and shall comply with all local regulations and codes of practice which apply to such Works.

8.9 INSTALLATION MATERIAL

8.9.1 The Material used for Installation as Permanent Works shall be new, rust free and complies with the relevant specifications.

8.9.2 Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of material delivered to the Site.

8.9.3 True copies of certificates, duly certified by the manufacturer and the Contractor may be submitted if the original certificates could not be obtained from the manufacturer.

8.9.4 Parts of material which are to be assembled on the Site shall be marked to identify the different parts.

8.9.5 Material which are specified by means of trade or proprietary names may be substituted by material from a different manufacturer which has received the consent of the Engineer provided that the material are of the same or better quality and comply with the specified requirements.

8.9.6 Samples of material submitted to the Engineer for information or consent shall be kept on the Site and shall not be returned to the Contractor or used in the Permanent Works unless permitted by the Engineer.

8.9.7 The samples shall be used as a means of comparison which the Engineer shall use to determine the quality of the material subsequently delivered. Material delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples which have received consent.

8.9.8 All the surplus serviceable material, if not required by the Employer, and unserviceable material shall be carried away from the Site by the Contractor and disposed off in the manner consented by the Engineer.

8.10 MOCK-UPS

The Contractor shall construct mock-ups, if required, to demonstrate to the satisfaction of Engineer that the designs of the elements of the System will fulfill the requirements of the Contract.

8.11 DISPOSAL OF SURPLUS MATERIAL

The disposal of surplus or waste material, debris of demolished existing structures or buildings and unsuitable material etc. shall be the responsibility of the Contractor and this material shall be treated and disposed of by the Contractor at an approved location(s) at his own cost. The disposal plan and program shall be subject to approval by the Engineer.

8.12 ASSET IDENTIFICATION

8.12.1 The Contractor shall submit for review by the Engineer an asset Information database as below but not limited to:

a. Asset Description;

b. Rating/ size details

c. Date Manufactured, Batch no.

d. Date of Installation

e. Testing log with date and results.

f. Failure History

8.12.2 All equipment and software shall have a unique identification number that can be identified electronically and manually.

8.13 TESTING & COMMISSIONING

8.13.1 The Contractor shall provide and perform all forms of Inspection and testing procedures applicable to the Works relating to plant & equipment and manufactured items and various components and the interfacing of the Works relating to plant & equipment and manufactured items with the other contractor(s) and shall conduct all necessary factory, site & acceptance tests.

8.13.2 The commissioning activity shall include a period of the Integrated System testing followed by a period of Trial Run.

8.13.3 Within 180 days from the date of Commencement of the Work, the Contractor shall submit a comprehensive Testing Program defining the personnel, procedure and format of testing.

8.13.4 All testing procedures shall be submitted at least 56 days prior to conducting any Test. The testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the acceptance criteria, the relevant drawing (or modification) status and the location.

8.13.5 The testing procedures shall be submitted by the Contractor and amended subsequently, if required, by the Contractor during the duration of the contract to reflect changes in design of works, interface systems or the identification of additional testing requirements, if needed.

8.13.6 The contractor shall facilitate the Employer's Personnel/ the Engineer to inspect the works and monitor all tests and have access to all testing records.

8.13.7 Sufficient time shall be allowed within the Testing Programs for necessary alterations to equipment, sub-systems and designs to be undertaken, together with re-testing prior to final commissioning.

8.13.8 The Contractor shall keep in mind that at some point of time, the electric Traction System shall be energized and the additional precautions for the safety and co-ordination of the activities prior to and after 'power-on' shall be anticipated in his co-ordination with other contractors and installation, testing and commissioning Programs of all the contractors and all associated with the Traction Power Energisation Program.

8.13.9 The testing/inspection of the material shall be done by the Engineer's and/or Employer's Representative and all costs associated with the testing/inspection shall be borne by the Contractor including travel/lodging/boarding charges of the Engineer's and/or Employer's Representative. Any testing/inspection charges to be paid to the Test Laboratories shall also be borne by the Contractor.

8.13.10 The Contractor shall bear all expenses including hotel/travel/cost of witnessing, if any, incurred due to retesting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

8.13.11 The Contractor shall provide and perform all types of tests applicable to the Works as stipulated in this GS and the PS.

8.13.12 The Contractor shall submit Test Plan(s) for approval by the Engineer and shall demonstrate that the tests are sufficient and adequate to meet the requirements of this Contract. This will include the EMC and EMI tests.

8.13.13 The witnessing of any Test by the Employer's personnel / Engineer shall not relieve the Contractor from his obligations, responsibilities and liabilities to complete the Works in accordance with the Contract nor relieve him of any of his obligations, responsibilities and liabilities under the Contract.

8.13.14 In the event of any test being performed in the countries other than India, the Contractor shall give at least 56 days' notice to the Engineer for witnessing the test. The Contractor shall not be required to bear the cost of the Employer's Personnel/ the Engineer visit i.e. travel expenses, boarding/lodging etc.

8.13.15 If test reports are not acceptable as proposed due to absence of approved Test plan and procedures and/or Reports, failure to fulfill the pass/fail criteria, negligence, lack of preparation or unacceptable material and/or equipment, all costs incurred by the Employer's Personnel, the Engineer or any other personnel nominated by the Employer for repeated inspection and/or witness shall be borne by the Contractor.

8.13.16 All testing equipment shall be pre-checked for calibration accuracy by third party as acceptable to the Engineer.

8.13.17 The Engineer/ Employer's personnel shall sign all test reports of the test witnessed by him.

8.14 SEQUENCE OF TESTS

The sequence of tests shall comprise as appropriate the following:

(1) Type Tests, as and when required;

(2) Routine Test carried out before offering for FAT,

(3) Factory Acceptance Tests (FAT);

(4) Installation Tests;

(5) System / Sub-system Acceptance Tests (SAT);

(6) Integrated Testing & Commissioning; and

(7) Trial Run.

8.15 TYPE TEST

8.15.1 Type tests shall be carried out on specific items to ensure that they perform their intended functions when subjected to all permutations and combinations of external environment and other factors. If Procured locally, shall be procured from RDSO/CORE approved sources only as per Indian Railway Policy. List of sources are available at RDSO / CORE websites.

8.15.2 In addition to the above, Type tests may also be performed for subsystems, components and items of equipment installed in the overall system in substantial numbers.

8.15.3 Type Test Reports and Certificates shall explicitly state the mandatory contents of the routine test Program and the individual inspection and measurement procedures that need to be performed on each individual item of identical series production devices or components.

8.16 FACTORY ACCEPTANCE TEST (FAT)

8.16.1 The Contractor shall conduct Factory Acceptance Tests (FAT i.e. Type/Routine/ acceptance/special tests) as specified in relevant standards & specifications at the premises of Original Equipment Manufacturer.as needed before dispatch of material.

8.16.2 All material, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subjected to test and certification. FAT procedure shall be submitted for review by the Engineer Twenty Eight (28) days in advance of carrying out any Test.

8.16.3 The FAT shall demonstrate that each equipment /sub-system meets its functional specifications.

8.16.4 No equipment or software shall be delivered to the Site until the Contractor has demonstrated, to the satisfaction of the Engineer that the equipment or software conforms to the specifications by carrying out the FAT.

8.16.5 Where processor based equipment is to be used, the FAT shall also include verification of software used in this application.

8.17 PRE-INSTALLATION TESTS

8.17.1 Prerequisites for Installation:

Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and ensure for their dimensional accuracy.

8.17.2 Inspection:

a. During the inspection, it shall be verified that

(i) The equipment has been installed as per the procedures & design that have been reviewed without objection by the Engineer and that equipment is correctly located and labeled.

(ii) Any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

b The Contractor shall maintain inspection records to demonstrate that each item of equipment has been inspected and found to be satisfactory and attach to this record a detailed list of any discrepancies found and remedial action taken.

c As defects are rectified, these shall be recorded on the appropriate inspection record.

8.18 POST-INSTALLATION TESTS

a. After installation of the equipment, visual inspection and operational tests on un-energized equipment shall be carried out to check the following:

(i) Cleanliness;

(ii) Workmanship;

(iii) Confirmation of items conforming to ratings specified;

(iv) Water and dust proofing;

(v) Leveling, mounting and positioning;

(vi) Joints and connections tightness;

(vii) Cables – dressing, bending radii, jointing and finish at terminals;

(viii) Clearances and dimensions in conformity with drawings;

(ix) Earthing and bonding;

(x) Functioning of circuit breakers, isolating switches and their interlocks;

(xi) Protection devices;

(xii) Phase sequence verification;

(xiii) Conformance to As Built Records.

b. During and on completion of installation, the Contractor shall undertake testing of all cables, wiring and equipment, instrumentation and protection devices including relays in a progressive sequence and in accordance with the overall-testing Programs.

c. The Contractor shall carry out installation tests for each sub-system following Installation but before SAT to demonstrate that the installation has been carried out correctly and equipment is properly housed and fixed.

d. These tests shall culminate in SAT to verify the correct operation of all apparatus and where appropriate, correct response to the respective control commands or monitored function.

8.19 SYSTEM ACCEPTANCE TESTS (SAT)

8.19.1 The Contractor shall prepare and organize a comprehensive Program of Tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract, when installed, connected and configured as a complete system meet the specified performance requirements in all respects.

8.19.2 Prerequisites and requirements for SAT to be satisfied before the commencement of the System Acceptance Tests (SAT) shall be as follows:

a. All documentation for the system safety report shall be submitted to the Engineer for review;

b. All Installation Tests shall be completed and test records submitted to the Engineer;

c. Facilities for the maintenance of the system shall be in place; and

d. The SAT Plan shall be submitted to the Engineer for review.

8.20 SAMPLES

8.20.1 In addition to any special provisions in the Contract for the sampling and testing of materials, the Contractor shall submit, in response to the request of the Engineer, samples of any materials or fittings which the Contractor proposes to use in the Works.

8.20.2 Such samples, if reviewed without objection, shall be retained by the Engineer for the duration of the Contract and no materials or goods of which samples have been submitted shall be used in the Works unless and until such samples shall have been reviewed without objection by the Engineer.

8.20.3 The Engineer may reject any materials and goods, which in its opinion are inferior to the samples previously approved and the Contractor shall promptly remove such materials/goods from Site.

8.20.4 Samples that have been tested may be utilized in the Works provided that:

a. The sample complies with the specified requirements;

b. The sample is not damaged;

c. The sample is not required to be retained under any other provision of the Contract; and

d. Consent of the Engineer has been obtained, in writing.

8.20.5 Additional samples shall be provided for testing, if in the opinion of the Engineer:

a. Material previously tested no longer complies with the specified requirements; or

b. Material has been handled or stored in such a manner that it may not comply with the specified requirements.

8.21 INTEGRATED TESTING

8.21.1 Integrated Testing on Completion shall include the Work of other contractor(s). The Contractor shall, following satisfactory completion of tests on his works, equipment, sub-systems or system, perform, at the direction of the Engineer, Program of tests to verify and confirm the compatibility and complete performance of his works, equipment, sub-systems or system with the works, equipment, sub-systems or system provided by others.

8.21.2 The Contractor shall submit to the Engineer the requirements and procedures in respect of the Contractor's scope of work for Integrated System Tests in conjunction with the other contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria.

8.21.3 Integrated Testing & Commissioning refers to those tests undertaken in order to demonstrate that the various components of the railway systems operate satisfactorily between one another and meet all specified requirements for design, operability, safety, and integration with other systems.

8.21.4 These tests shall be entirely within the requirements of one or more of the Project Contracts or they shall involve a multiplicity of Contract procedure. The final Integrated Testing and Commissioning shall be carried out after the SCADA system and OCC have become operational.

8.21.5 Those systems that can be tested without depending on the running of trains, such as SCADA and Telecom system etc., will have their integration tests scheduled to commence as early as possible. It is preferable that any interface problem associated with these "train less" system tests be identified and resolved prior to the commencement of test running.

8.21.6 The Integrated Tests by the Contractor and other contractors shall include a period of Trial Run.

8.21.7 The results of the Integrated Testing and Commissioning shall be compiled and evaluated by the Engineer and the Contractor.

8.21.8 If the Works, or a part thereof, or a Section, or a plant & equipment and manufactured item fail to pass Integrated Testing and Commissioning and the Contractor in consequence proposes to make any adjustment or modification to the Works or a part thereof, or a section, or the plant & equipment and manufactured item, the Engineer may, with the approval of the Employer, instruct the Contractor to carry out such adjustment or modification at his own cost to satisfy the requirements of Integrated Testing and Commissioning within such time as the Employer / Engineer may deem to be reasonable.

8.21.9 If the Works, or a part thereof, or a Section, or a plant & equipment and manufactured item fail to pass the Integrated Testing and Commissioning, the Engineer shall require such failed Test(s) to be repeated under the same terms and conditions. If such failure and retesting results due to the fault of the Contractor and cause the Employer to incur additional cost, the same shall be recoverable from the Contractor by the Employer and shall be deducted by the Employer from any money due or to become due, to the Contractor.

8.22 STATUTORY REQUIREMENTS

The Contractor along with others Contractor(s) shall carry out all statutory tests and trials under the supervision of the Engineer, necessary for obtaining sanction of the competent authority, if required, for opening the Railway System.

8.23 TRIAL RUN AND COMMISSIONING

Following satisfactory completion of the Integrated System Test, the Employer will commence an extended period of trial run to prove all technical systems to the satisfaction of the Engineer and Commissioner for Railway Safety or any other Authorized Official and to allow all technical systems to settle and to train staff to become conversant with the working procedures. The Contractor's personnel shall be available throughout the scope of work over the whole of this period. After successful Trail Run and obtaining statutory clearances / approvals from CRS / EIG and / or other relevant authorities, the Works shall be commissioned with the consent of the Engineer.

8.24 TESTING RECORDS

8.24.1 Tests Reports

(1) The Contractor shall submit manufacturer's type and routine test certificates and reports for each equipment and device. Complete test results are to be submitted in clearly identified and organized booklet, indicating item of equipment, make, model, type, date of tests, and type of tests, descriptions and procedures. Test reports shall also include the Quality Assurance Certification, the standards to which the equipment comply, and the standards to which the equipment was tested.

(2) The Contractor shall submit to the Engineer for review, not less than three (3) months before testing and commissioning activities commence his proposed format for testing and the commissioning records. The records shall be appropriately sub-divided to make provision for the various parts of the Permanent Works covered by the Contract.

(3) The format of the records shall cover all tests, provide positive identification by serial number for assemblies and sub-assemblies of the Works and show modifications to Employer's drawings and diagrams or "As Built" data to be certified by the Engineer in the course of installation, testing and commissioning.

(4) The Contractor shall, during the execution of the Works, prepare such reports and record of design, manufacture, installation and testing, as may be required, in order that a license may be issued or statutory requirements may be met or approval given. Such reports or records shall be adequate to enable each part of the Permanent Works to be commissioned and to meet the requirements of the licensing authority or any standing statutory regulations and shall be reviewed by the Engineer.

(5) The Contractor shall obtain report of each inspection and/or test. Such report shall show the result of all the inspections and/or tests carried out and shall certify that the work has been inspected and/or tested in accordance with the requirements of the Contract and that the work complies with the requirements of the Contract.

(6) The Contractor shall prepare an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Engineer. If the Employer or the Engineer or Employer's Representative has witnessed the inspection or test, he may countersign the inspection or test report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily contained therein). If the Employer or the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or the Employer or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Employer/ the Engineer may call for a re-inspection or re-test.

(7) The Contractor shall carry out an analysis of the results and certify that the work has been inspected/tested in accordance with the requirements of the contract and the work complies with the requirements of the Contract.

(8) Authorized representative of the Contractor, who has been assigned the required authority under the relevant quality plan, shall sign each report of inspection and/or test.

(9) In addition to any other requirements, the report shall contain but not limited to as below:

a. Material or part of the Works tested;

b. Location of the batch from which the samples were taken or location of the part of the Works;

c. Place of testing;

d. Date and time of tests;

e. Weather conditions in the case of in-situ tests;

f. Technical personnel supervising or carrying out the tests or inspection;

g. Size and description of samples and specimens;

h. Method of sampling;

i. Properties tested or inspected;

j. Method of testing or inspection;

k. All relevant checklists and work sheets used during the inspection and/or test , including readings and measurements taken during the tests;

l. Test results, including any calculations and graphs;

m. Specified acceptance criteria; and

n. Other details stated in the Contract.

8.24.2 After Commissioning of a part of the Works, the Contractor shall complete each commissioning record in the agreed format and shall forward copies of the record to the Engineer for review.

(End of Chapter 8)

CHAPTER 9 - SITE SAFETY PLAN

9.1 GENERAL

9.1.1 HRIDC has prepared its own Safety, Health and Environment (SHE) Manual which is attached in Reference Documents – Part 2, Section VII-4 of Bidding Documents. This SHE Manual shall be applicable on the Works being carried out under this Contract. Various penalties as stipulated in the said manual shall be applicable under this Contract for violation of relevant stipulations.

9.2 CONTRACTOR'S RESPONSIBILITY FOR SAFETY

9.2.1 The Contractor shall comply with all safety and industrial health legislation including, without limitation to the rules and regulation of the National Safety Council of India.

9.2.2 The Contractor shall develop its own Safety and Health procedures and systems in line with SHE Manual of HRIDC and in compliance to applicable acts and legislations.

9.2.3 The Contractor shall, within fifty six (56) days of the Commencement Date, prepare and submit to the Engineer for review his proposed Safety, Health & Environment Management Plan.

9.2.4 The Contractor is required to develop systems and procedures for ensuring compliance with all the precautions required for the safety of the workmen.

9.2.5 The Contractor shall produce a policy statement signed by the Managing Director of the Contractor or other senior officer acceptable to the Engineer, or the Managing Directors or other senior officers acceptable to the Engineer of each company of the consortium, partnership or joint venture comprising the Contractor,

(1) Declaring that the safety and industrial health will be given priority consideration in all aspects of the Works and by the Contractor in discharging his contractual obligations;

(2) Reflecting an understanding of and means of ensuring due compliance with the statutory regulations and standards relating to construction work in India;

(3) Indicating the statutory and contractual obligations regarding safety, rescue and industrial health imposed on the Contractor and the means by which the Contractor will supervise, monitor and audit his site safety assurance system to ensure due compliance with these obligations.

9.2.6 The Contractor must comply with all regulation regarding scaffolding, ladders, working platform, excavation, etc. as per SHE manual of HRIDC.

9.3 APPOINTMENT, DUTIES AND RESPONSIBILITIES OF SAFETY STAFF

(1) The safety staff and organizational structure, which should identify the personnel to be, engaged solely for site safety assurance, the responsibilities of the participants and the subdivision of the site safety assurance tasks into elements which can be effectively controlled, technically and managerially.

(2) Names, addresses, telephone, email and fax numbers of all participants shall be listed where known (supplements to the site safety plan will update and complete this information).

(3) The powers vested in the safety staff, which shall be sufficient to enable them to take urgent and appropriate action to make safe the site and prevent unsafe working practices or other infringements of the safety plan or statutory regulations.

9.4 POLICY FOR IDENTIFYING HAZARDS

The Contractor shall produce a list of safety and health hazards identified for this Contract and the procedures and method statements for achieving effective and efficient minimization of the risks associated with such hazards. Such list shall also include the aspects of temporary work design which directly or indirectly has an impact on the safety of the works. These shall be submitted to the Engineer for his approval.

9.5 SAFETY AND HEALTH PROCEDURES

(1) The Contractor shall produce regulations and procedures covering all safety and health aspects of the Works, including where appropriate but not limited to the following:

a. Housekeeping

b. Working on or near operating railways

c. Fire prevention precautions and firefighting equipment

d. Working in confined spaces

e. Excavation

f. Hot weather working

g. Electrical equipment

h. Welding/cutting operations and equipment

i. Personal protection clothing and equipment

j. Cranes/ Hoists/ Other lifting appliances

k. Manual lifting/ Ladders/ Hand & Power tools

l. Hazardous substances

m. Working at height

n. Structural steel erection

o. Lighting

p. Protection against falling objects;

q. Power Block/Permit to Work

9.6 SUB-CONTRACTORS

(1) The means by which safety, rescue and industrial health matters and requirements will be communicated to sub-Contractors of all tiers and their due compliance with the site safety plan and all relevant statutory regulations is ensured by the Contractor.

(2) The method by which the safety procedures and practices proposed by sub-Contractors will be reviewed for compliance with the site safety plan and statutory

regulations including the provision of hazard and risk assessments and method statements.

9.7 DISCIPLINARY PROCEDURES

The Contractor's disciplinary procedures with respect to dealing with safety related matters both with his own staff and that of sub-Contractors shall be given.

9.8 ACCIDENT REPORTING

The Contractor's procedure for reporting and investigating accidents, dangerous occurrences or occupational illness;

9.9 SAFETY PROMOTION

The Contractor shall provide details of the frequency, coverage and intent of site safety meetings together with the rationale for attendance.

9.10 SITE SECURITY

(1) The Contractor's system for the protection of authorized and unauthorized visitors to the site;

(2) The Contractor's proposals to ensure that construction methods do not compromise the Contractor's commitment to the site safety plan or its compliance with the statutory regulations.

9.11 LABOUR SAFETY

(1) The activities of Contractor shall be co-ordinated with all Contractors and Indian Railways so as to ensure safety of all Contractors' personnel as required.

(2) Labour safety arrangements by the Contractor shall be in accordance with the applicable legislation in India.

(3) The design and construction shall comply with the applicable legislation in India.

(4) The Contractor shall provide the equipment needed for the labour safety during the operation of the line.

9.12 LEGISLATION AND CODES OF PRACTICE

(1) The Contractor shall comply with all safety and industrial health legislation including, without limitation, the rules and regulation of the National Safety Council of India.

(2) The Contractor shall keep on the site copies of safety and industrial health regulations and documents.

(3) All regulations and documents referred in this clause shall be translated into languages which are understood by the operators and supervisors engaged by the Contractor or sub-Contractors and such translations shall be displayed or kept alongside those in English language.

9.13 SITE SAFETY PLAN

The brief outline of site safety plan shall cover the following:

(1) Safety Personnel

a. The Contractor shall appoint a 'System Safety Expert' whose duties throughout the period of the Contract shall be entirely connected with the safety and industrial health aspects of the Contractor's activities on the site.

b. The System Safety Expert shall be a suitably qualified and experienced person who shall supervise and monitor compliance with the site safety plan.

c. The System Safety Expert shall, in particular but without limitation, carry out auditing of the operation of the site safety plan in accordance with a rolling program to be submitted, from time to time, to the Engineer for his consent.

d. The System Safety Expert's appointment shall be within Ninety Eight (98) days of the Commencement Date and shall be subject to the Engineer's written consent.

e. The Contractor shall not undertake any works on the site until the System Safety Expert has commenced duties at site and unless the Engineer has specifically consented in writing.

f. The Contractor shall not remove the System Safety Expert from the site without the express permission of the Engineer. Within fourteen (14) days of any such removal or notice of intent of removal, the Contractor shall nominate a replacement safety officer for the Engineer's consent.

g. The Contractor shall maintain the adequate supporting Safety Inspection staff at each site during the execution of work in accordance with the staffing levels set out in the site safety plan. Such safety assurance staff shall be deployed for each shift of duty at work site.

h. The supporting staff shall include at least one Deputy System Safety Expert, whose appointment(s) shall be subject to the Engineer's consent.

i. The Deputy System Safety Expert (s) shall be capable of assuming the duties and functions of the safety officer as contained in the site safety plan whenever necessary.

j. The Contractor shall ensure that the System Safety Expert maintains a daily site safety diary, such diary comprehensively recording all relevant matters concerning site safety, safety inspections and audits, safety related incidents and the like.

k. The site safety diary shall be reviewed and signed on a weekly basis by the Contractor's site representative and shall be available at all times for inspection by the Engineer.

l. The Contractor's staff organization plan shall show direct lines of communication and reporting between the System Safety Expert and the Contractor's site representative and between the safety officer and the person responsible for the Contract.

m. The Contractor shall instruct and require the Contractor's site representative and the person responsible to be directly accountable in all matters concerning site safety.

(2) Site Safety Inspections

a. The Contractor will conduct site safety inspections at a regular frequency by the nominated System Safety Expert.

b The findings of the inspections shall be recorded on suitable forms which shall be kept available for inspection by the Engineer.

(3) Safety / Accident Reporting

a. The Contractor’s System Safety Expert shall submit regular site safety reports to the Engineer in accordance with the site safety plan.

b. Such reports shall be submitted as part of the Monthly Progress Report. Prior to submission, the site safety report shall be endorsed by the Project Manager responsible for the Contract and the Contractor’s site representative.

c. Site safety reports shall comprehensively address all relevant aspects of site safety and industrial health regulation and, in particular, report on all site safety audits undertaken during the period covered by the report.

d. The Engineer shall be notified by the Contractor immediately of occurrence of any accidents whether on-site or off-site in which the Contractor, its personnel or plant, or those of its sub-Contractors are directly or indirectly involved and which results in any injuries to any persons, loss / damage to plant and machinery, disruption of traffic etc.

e. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

f. Additionally the Contractor shall notify the Engineer in writing within twenty four (24) hours of any incident occurring whether on-site or off-site at which the Contractor or any sub-Contractors are involved and could have resulted in serious injuries to persons or significant damage to the Works. Failure to report such incidences shall be considered as a serious breach of Safety Procedures.

(4) Sub-Contractors

a. The Contractor shall provide its sub-Contractors with copies of the site safety plan and shall incorporate into all sub-contract documentation provisions to ensure the compliance with such plan at all tiers of the sub-contracting.

b. The Contractor shall, with the Engineer's consent in writing, instruct all sub-Contractors to appoint a safety representative who shall be available on the site throughout the operational period of the respective sub-contract.

c. These safety representatives shall ensure that all employees of sub-Contractors working at site are conversant with appropriate sections of the site safety plan and the statutory regulation.

(5) Safety Meetings

a. The Contractor shall convene regular safety meetings in accordance with the safety plan and shall ensure attendance by the safety officer and safety representatives of sub-Contractors unless otherwise agreed by the Engineer.

b. All safety meetings shall be notified in advance to the Engineer who may attend in person or by representative at his discretion.

c. The minutes of all safety meetings shall be taken and sent to the Engineer within seven (7) days of the meeting.

d. A site safety management committee may be established by the Engineer to monitor the implementation of the safety plan and for the purposes set out in the project safety manual.

e. The Engineer or his representative will be the Chairman of this committee and the members shall include the Contractor's agent or representative, safety manager and safety officers, sub-Contractors' safety personnel.

(6) Safety Equipment

a. The Contractor shall produce policy and procedures for ensuring that all his plant and equipment used on the works site is maintained in a safe condition and is operated in a safe manner.

b. The means by which safety equipment, scaffolds, guard-rails, working platforms, hoists, ladders and other means of access, lifting, lighting, signing and guarding equipment shall be inspected, tested and maintained and the standards below which such items will be removed from the site and replaced shall be elaborated.

c. The Contractor shall identify the safety equipment, rescue apparatus and protective clothing which will be required for the Works.

d. The identification shall include the quantity, sourcing, standards of manufacture, storage provisions and means of ensuring proper utilization by all workmen and staff employed directly or indirectly by the Contractor and repair to or replacement of damaged equipment.

e. The Contractor shall ensure that safety equipment and protective clothing as described in the safety plan is available and used on the site at all material times and those measures for the effective enforcement of proper utilization and necessary replacement of such equipment and clothing is incorporated into the site safety plan. Such equipment shall include, but not be limited to, site helmets, goggles and other eye protectors, hearing protectors, safety harnesses, safety equipment for working in confined spaces (e.g. sewers, drains etc.), rescue equipment, equipment to rescue persons from drowning (if applicable), fire extinguishers, first aid equipment, and, where appropriate, suitable fall arrest equipment.

f. The Contractor shall regularly inspect, test and maintain all safety equipment, scaffolds, guard-rails, working platforms, hoists, ladders and other means of access and egress, lifting, lighting, signage and guarding equipment.

g. Lights and signs shall be kept clear of obstructions and legible to read.

h. Equipment which is damaged, dirty, incorrectly positioned or not in working order shall be repaired or replaced immediately.

(7) First Aid

The Contractor shall establish, maintain, staff, and fully equip a first aid base as detailed below:

a. First Aid Base

i. First aid bases shall be located at each of the Contractor's principle work area.

ii. The First Aid base shall consist of a treatment room fitted with two treatment couches, two stretchers, a hand wash basin, sterilizing equipment and lockable cupboards to contain sufficient medical supplies for the Contractor's personnel, the Employer's / the Engineer's personnel including visitors to the Site.

iii. The first aid base shall contain a recovery room that shall be furnished with six chairs and a center table.

iv. The first aid base shall be air-conditioned with cooling and heating capability sufficient to maintain the inside temperature at 22^0C.

v. Portable First Aid box shall be maintained fully equipped at each of local site offices and work locations where twenty (20) or more persons work at a time.

b. Staffing

i A qualified doctor shall be available on call during all times when work is being undertaken on Site.

ii A nurse/ para medical staff shall be in attendance at the first aid bases during all times when work is being undertaken on the Site.

iii In each Site office and location, at least one employee of the Contractor shall be trained in first aid and shall be available during all working hours for the purpose of attending to emergencies.

iv The Contractor may conclude a contract with the local health centre(s), where they are unable to implement any of the above services, as approved by the Engineer.

c. Equipment

i A fully equipped ambulance and driver shall be available on call during all working hours.

ii The ambulance shall be equipped with emergency life support equipment suitable for application in construction Site accidents.

(8) Site Publicity

a. The Contractor shall ensure that safety, rescue and industrial health matters are given a high degree of publicity to all persons regularly or occasionally on the site.

b. Posters, in both Hindi and English, drawing attention to site safety, rescue and industrial health regulation shall be made or obtained from the appropriate sources and shall be displayed prominently in relevant areas of the site.

c. These posters shall be changed on a monthly basis in order to ensure their continued impact.

d. All personnel whether permanent, temporary or visitors, will be given a site safety induction before they are allowed on to the site.

(9) Training

a. The Contractor shall conduct regular safety training and rescue training drills, the frequency, coverage and application of which shall be in accordance with the site safety plan and in any case shall not be more than every six months. Engineer may monitor the content of such training programs.

b. The Contractor shall require that all sub-Contractors' employees participate in relevant training courses appropriate to the nature, scale and duration of the sub-contract works.

c. The Contractor shall produce a description of the safety training courses that are to be provided. The syllabus, frequency, coverage and application of training courses shall be included together with the means of attaining the objective that all workmen shall be required to attend a safety induction course within their first week on site and thereafter at times appropriate to their prospective duties and at intervals of not more than six months. A summary of such training program conducted/ planned shall form part of Monthly Progress Report.

(10) Breach of Safety Regulations

a. Any employee of the Contractor or sub-Contractor of any tiers who commit a serious breach of the safety regulations shall be liable to summarily dismissal and shall not be re-employed on the Contract or allowed on any of the sites.

b. The due notice of this sanction shall be prominently displayed on the site.

(11) Safety Devices

a. All plant and equipment used on or around the site shall be fitted with appropriate safety devices which shall be operational at all times and shall be regularly inspected and tested.

b. These shall include, amongst others, effective safety catches for crane hooks and other lifting devices.

c. Functioning automatic warning devices and where applicable, an up-to-date test certificate, for cranes and hoists.

d. All plant and equipment used on or around the site shall be operated by suitably trained and qualified personnel with valid licenses from the appropriate authorities.

(12) Testing and Certification of Lifting Gear

a. The Contractor shall provide and maintain safe mechanical cranes, hoists and conveying facilities for the lifting and transport of material and shall comply with all relevant codes of practice for safe use of cranes.

b. All cranes, hoists and the like shall be fitted with audible overload warning devices.

c. All such equipment shall be regularly maintained in accordance with manufacturers' recommendations and standards having regard to local legislation and recommendations from the appropriate statutory authority.

d. Prior to use on site, all lifting appliances and lifting gears shall be tested to an approved safety margin and suitably identified in accordance with the requirements of the current legislation. The test certificate shall be submitted to the Engineer for review prior to the use of such equipment on site.

e. The safe working load shall be clearly and indelibly marked on all lifting appliances and lifting gear either by stamping or by the addition of permanently secured tag labels. Stamping shall not be permitted on any stress-bearing part.

f. The Contractor shall prepare and maintain an up-to-date register containing test certificates of all lifting and hoisting equipment used on the Works. The register shall, from the commencement of construction, be available on site for inspection by the Engineer and relevant authorities.

g. Heavy plant or equipment, which does not come under the jurisdiction of any local statutory legislation, shall be subject to the testing and examination requirements as recommended by its manufacturer or in the absence of such, it shall be the responsibility of the Contractor to submit a standard or method of testing and examination to the Engineer for review.

h. Competent operators with certificates certifying that the proposed operator has received training in the general principles of crane operation and specific training in the type of lifting or hoisting equipment he is required to operate shall be provided for the control of all lifting and hoisting equipment.

(13) Fire Regulations and Safety

a. The Contractor shall provide and maintain all necessary temporary fire protection and firefighting facilities on the site during the construction of the Works, and shall comply with all requirements of the local fire services department.

b. These facilities may include, without limitation, sprinkler systems and fire hose reels in temporary site buildings, raw water storage tanks and portable fire extinguishers suitable for the conditions on the site and potential hazards.

c. The Contractor shall submit details of these facilities to the Engineer for review prior to commencement of work on the site.

d. If, in the Engineer's opinion, the use of naked lights may cause a fire hazard, the Contractor shall take such additional precautions and provide such additional firefighting equipment as the Engineer considers necessary.

e. The term "naked light" shall be deemed to include electric arcs and oxyacetylene or other flames used in welding or cutting metals.

f. Oxyacetylene burning equipment will not be permitted in any confined space. If required, the burning equipment of the oxy-propane type shall be used.

(14) Interface with Indian Railway Operations

a. The Contractor will review the interfaces with Indian Railway's operations and prepare a specific safety plan for all works that may affect the operating railway.

b. The Contractor will comply with and incorporate Indian Railway's rules and regulations for track, Signalling and operations possessions into his safety plan and will operate a permit to work system for all works which may affect the operations of the existing railway.

Similarly, the site safety plan shall consider with other interfacing contractors in the closed vicinity of the Employer.

(15) Electrical Safety

a. Safety measures while working in OHE area

i While working near the OHE area, as a minimum the safety guidelines as specified in para 20301, 20327, 20334, 20335, 20529, 20612, 20614, 20714, 20825, 20833, 21206 and 21207 of Volume II, Part 1 of AC Traction Manual of Indian Railways shall be followed.

ii No work close to the live OHE shall be carried out without power block unless the work area is properly screened, barricaded, earthed and supervised by a competent Engineer subject to specific approval from Engineer / Employer.

iii A minimum Working Clearance of 2m shall be maintained between live OHE wire and any body part of the workmen or tools or metallic support etc.

iv No electric connection shall be tapped from OHE.

b. Safety Requirements for Electrical Works

i The Indian Electricity Rules 1956 and Indian Electricity Act 2003 as amended up to date shall be followed. The detailed instructions on safety procedures given in Indian Standards, Indian Electricity Rules and respective State Electricity Authorities' regulation with up to date amendment shall be applicable.

ii The LT/HT distribution diagrams of sub stations shall be prominently displayed. The substation premises, main switch rooms and D.B. enclosure shall be kept clean whenever works are carried either inside or outside.

iii No flammable material shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act

iv Protective and safety equipment such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus, safety goggles etc., shall be provided as per the requirement of the Work.

v Necessary number of caution boards such as "Man working on line, Don't switch on" shall be readily available in the vicinity of electrical installation.

vi Standard first aid boxes containing material as prescribed by the St. John's Ambulance Brigade or Indian Red Cross shall be made available.

vii Charts displaying methods of giving artificial respiration to a recipient of electrical shock (one in English and another one in the regional language) shall be prominently displayed at appropriate places.

viii No work shall be undertaken on live installations, or on installation, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.

ix No work on live L.T. bus bar or pedestal switch board in the sub stations should be handled by a person below the rank of a Licensed Wireman and such a work should preferably be done in the presence of a qualified engineer.

x When working on or near live installations, suitable insulated tool should be used and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.

xi The electrical switch controls in distribution boards shall be clearly marked to indicate the areas being controlled by them.

xii Before starting any work on the existing installation, it shall be ensured that the electric supply to that portion is cut off. Precautions, like displaying "Men at Work" caution boards on the controlling switches, removing fuse carrier from these switches shall be taken against accidental operation. Caution boards shall be kept with the person working on the installation.

xiii All equipment / sub-systems shall conform to relevant IEC standard on Electromagnetic Compatibility (EMC).

xiv The Contractor shall provide adequate stand-by equipment to ensure the safety of personnel, the Works and the public.

(16) Co-operation

The Contractor shall provide full co-operation and assistance in all safety surveillance carried out by the Engineer or the Employer. Any breaches of the site safety plan or the statutory regulations or others disregard for the safety of any persons may be the reason for the Engineer to exercise his authority to require the Contractor's site representative's removal from the site. Besides this Engineer may impose token penalty for such lapses as considered fit.

9.14 HEALTH

The Contractor shall ensure that the provision of SHE Manual of the HRIDC regarding occupational health & welfare are follow for workmen deployed under this Contract.

(End of Chapter 9)

CHAPTER 10 - INTERFACE MANAGEMENT PLAN

10.1 GENERAL

(1) The System Contractor (SYS-1) shall be responsible for interface planning and management of all the systems works: Power supply Installations, OHE, ROCS, and SCADA works within the scope of his Contract with the Civil / Tunnel / Bridge / Track Works Contractors, Signalling & Telecommunications Contractor, OHE Contractor (MSIL(OHE)) and other dedicated Contractor(s) in the adjoining section(s) including IR/DFCCIL and other regulatory agencies.

(2) The Contractor shall co-ordinate its interface requirements with the Employer and other interfacing contractors i.e**.** CST and other contractor(s) etc. which the Employer may engage from time to time in such a manner so as to minimize disruption to any party arising from such concurrent work.

(3) The co-ordination responsibilities of the Contractor shall include, but not be limited to the following:

a. Provision of all information reasonably required by the interfacing parties in a timely and professional manner to allow them to proceed with their design or construction activities and specifically to meet their contractual obligations.

b. Assurance that the interfacing parties' requirements are provided to all other interfacing parties in time providing them ample opportunity to do their part of requirement for interfacing.

c. Receipt from the interfacing parties of such information as is reasonably required to enable the Contractor to meet the design submission schedule as identified in Chapter - 4 "Project Program Requirements" of this GS.

d. Where the execution of the work of the interfacing parties depends upon the Site management or information to be given by the Contractor, the Contractor shall provide to such interfacing parties the services or information required to enable them to meet their own program or to enable them to construct their work.

e. Co-ordination of track possessions, access and delivery routes, and assurance that all provisions for access and delivery of Plant are coordinated with and reflected in the interfacing parties' delivery route drawings.

f. Co-ordination with the interfacing parties in attendance.

g. The Contractor shall conduct separate meetings with the interfacing parties as necessary to clarify particular aspects of the interfacing requirements of the Works.

h. The party convening the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.

i. Assurance, copies of all those correspondence, drawings, meeting minutes, programs, etc. relating to the Contractor's co-ordination with the interfacing parties are issued to all concerned parties and four (4) copies issued to the Engineer no later than seven (7) calendar days from the date of such correspondence and meetings.

(4) The Contractor shall, in carrying out his co-ordination responsibilities, provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the interfacing parties as to the extent of services or information required to pass between them.

a. If such disagreement cannot be resolved by the Contractor despite having taken all reasonable efforts, the decision of the Engineer shall be final and binding on the Contractor(s).

b. Where an interfacing contract is yet to be assigned, the Contractor shall proceed with the co-ordination activities with the Engineer until such time as the interfacing contractor is appointed.

c. The Contractor shall note that the information exchange is an iterative process requiring exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the respective dates.

d. The Contractor shall co-ordinate with the Engineer on all matters relating to works that may affect the IR operation on the existing railway. Such works shall be carried out in accordance with IR Rules and Regulations.

10.2 INTERFACE MANAGEMENT PLAN (IMP)

(1) Contractor shall be responsible for identifying all internal and external interfaces and shall develop and maintain a full interface management system which shall cover the functional and technical aspects of all the internal and external interfaces of the Contractor.

(2) The Contractor shall prepare and submit an IMP which shall identify the interface manager, the structure and responsibilities of the interface management team and the procedures that will be implemented to identify and close out all interfaces.

(3) The Interface Management Plan shall:

a. Identify the sub-systems as well as the works and facilities with interfacing requirements;

b. Define the authority and responsibility of the Contractor's and all other contractors' (and any relevant sub-contractors') staff involved in interface management and development;

c. Identify the information to be exchanged, precise division of responsibility between the Contractor and the other contractor(s) and integrated tests to be performed at each phase of the Contractor's and other contractors' works;

d. Address the works program of the Contract to meet the key dates of each contractor and highlight any program risks requiring the Employer's attention keeping in view timeline of systems contractor;

e. Address the interface issues during Design as well Construction.

(4) The Interface Management Plan shall include procedures for identifying and resolving interfaces within the Contractor's scope of work between the Contractor and the Employer and between the Contractor and other contractor(s).

(5) The timescale for resolving interfaces shall be set down in Co-ordinated Installation Plans (CIP) and with the other contractors.

(6) All interfaces shall be documented through the use of interface co-ordination documents to ensure that each interface is identified, the responsibilities to provide information are defined, the criteria for resolution are agreed and the progress to resolution can be tracked at all times.

10.2.1 Design Interface

(1) The Contractor shall commence the design interface with the interfacing contractor as soon as he has been notified by the Engineer that the contract has been awarded to the Interfacing contractor.

(2) In the case of utility agencies and other statutory boards, interfacing shall commence as soon as it is practicable.

(3) The Contractor shall, immediately upon award of Contract, gather all necessary information and develop his design to a level where meaningful interaction can take place.

(4) The Contractor shall submit together, with each of his Design submissions a joint statement from the Contractor and the relevant interfacing party confirming that design co-ordination has been completed and that they have jointly reviewed the appropriate document to ensure that a consistent design is being presented.

(5) The design interface is an iterative process requiring regular exchange and update of interfacing information and the Contractor shall ensure that the information it requires from the interfacing parties is made known at the outset of each design interface so that the information can be provided in time for the Contractor and the interfacing parties to complete their design to meet their various design submission stages.

10.2.2 Construction & Installation Interface

(1) Construction & Installation interfacing will be necessary throughout the duration of the Works commencing from the time the Contractor mobilizes on the Site to the completion of the Works. Construction interfacing will overlap the design interface and involve the definition of interfacing parties' requirements that are to be incorporated at the initial stages of the Contractor's installation up to provision of attendance during the testing and commissioning stage.

(2) The Contractor shall ensure that there is no interference with the Works of the interfacing parties and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner.

(3) The Contractor shall carry out and complete the Works or part thereof, in such order as may be agreed by the Engineer or in such revised order as may be instructed by the Engineer from time to time.

(4) The Contractor shall liaise with the other contractors in the preparation of Co-ordinated Installation Plan (CIP) which shall include plans prepared collectively and agreed between the Contractor and any other contractor.

a. These CIPs shall show, in respect of each other contractor, a design interface, Site access, and installation interfacing.

b. The Design Interface phase shall be sufficient for the Contractor and the other contractors to integrate the designs of their respective works.

c. The installation interface shall be agreed between the Contractor and the other contractors to ensure that each has sufficient access to the Site for the purpose of carrying out their respective works. The Installation interface shall commence after the Design interface of the related activity is concluded.

d. The CIP shall be fully conforming to the approved Works Program and shall be in logical agreement with all access and Mile stones which shall be clearly identified in the CIP.

e. The CIP shall indicate dates for the commencement and completion of each principal activity on Site and delivery and installation of principal items of equipment.

f. The CIP shall be updated at regular intervals not exceeding 28 days and agreed with other contractors subject to the approval of the Engineer.

g. Should it appear to the Engineer that the actual progress of the Works, the Works Program or the three month rolling program do not conform with the CIP, the Contractor shall be required to revise all such programs and plans such that they do reflect the progress of the Works, are mutually consistent and conform to other provisions of the Contract.

h. The CIP shall allow adequate time periods for each interfacing party and the Contractor to install their plant and equipment in the interfacing areas.

i. The CIP shall be agreed with and signed by each interfacing party and then submitted to the Engineer not later than three (3) months before the earliest Works Area access date.

10.2.3 Employer's / Engineer's Input

(1) The Engineer will coordinate the activities of the Contractor with reference to interfacing with other contractors and agencies during all the phases of the Contract.

(2) The Employer/Engineer, within the scope of the relevant Contract provisions, will support and assist the Contractor for interfacing with Indian Railways Authorities, State and local authorities for timely receipt of the required permits, certificates and approvals related to the design and construction process;

(3) This support and assistance of the Employer/Engineer shall not absolve the Contractor of any of his obligations under this Contract.

10.3 INTERFACE CO-ORDINATION DOCUMENT (ICD)

(1) The Contractor shall create, in co-ordination with the other contractors, an Interface Co-ordination Document (ICD) for each interface, which shall be signed by all the parties involved.

(2) An interface list shall be prepared and maintained by the Contractor and updated on a regular basis to reflect the actual needs of both parties.

(3) The Contractor shall co-ordinate all interface items on the list and agreed solutions with the other contractors.

(4) ICD shall be created for each interface describing, in a formal manner, the particulars of the functional and technical requirements to be implemented.

(5) ICD shall be updated on a regular basis as information becomes available or agreement is reached between two contractors.

10.4 DEDICATED CO-ORDINATION TEAM

(1) The Contractor shall establish a dedicated co-ordination team led by an Interface Manager cum Co-ordinator reporting to the Contractor's Project Manager.

(2) The primary function of the team is to provide a vital link between the Contractor's design and manufacturing teams and other contractors. The Contractor shall provide the Engineer with the particulars of the Interface Manger cum co-ordinator.

(3) The Engineer shall have the right to replace the Interface Manager cum co-ordinator if in his opinion the Interface Manger cum co-ordinator is unable to meet the co-ordination requirements of the Contract.

(4) The Contractor's attention is drawn to the need for the Interface Manger cum co-ordinator to establish effective dialogues and communication links with the CST, S&T and other interfacing contractors. The Contractor's co-ordination team for interfacing shall comprise a mix of personnel with experience in both design and manufacture of equipment comprising the Works, necessary for effective co-ordination.

(5) The Interface Manager cum co-ordinator shall assess the progress of co-ordination with CST, S&T and other contractors by establishing lines of communications and promoting regular exchange and updating of information so as to maintain the Contractor's program.

(6) The complexity of the project and the importance of ensuring that work is executed within the stipulated time require detailed programming and monitoring of progress so that early program adjustments can be made in order to minimize the effects of potential delays.

10.5 CO-ORDINATION WITH OTHER CONTRACTORS AND INDIAN RAILWAYS

(1) The Contractor shall undertake design co-ordination with other contractor(s) and Indian Railways.

(2) The Contractor may commence design interfacing with other contractors and Indian Railways prior to the given period once information has been developed to a level where meaningful interaction can take place.

(3) Design co-ordination shall include, but not be limited to, the following:

a. Definition and agreement with other contractors of interface areas and contract limits;

b. Definition and design approach by the Contractor with the other contractors and/or Indian Railways regarding environmental control requirements, system functionality requirements and control interfaces;

c. Agreement of combined service drawings and structural opening drawings.

(4) The Contractor shall liaise with the Engineer in developing a uniform identity code system which shall be used to uniquely identify each item of equipment and software component provided under this Contract and provided by the other contractors and/or Indian Railway.

(5) Such identity codes shall be used for labelling each item of equipment and shall

also be used in design reports, drawings and operations and maintenance manuals. Such codes shall comprise mnemonics for location names and equipment types as well as alpha-numeric for unique numbering.

(6) The Contractor shall undertake Site activity co-ordination with the other contractors and/or Indian Railways within the periods stated for access and installation interfacing and co-ordination in the agreed CIP.

(7) The Contractor shall undertake installation and testing in accordance with the milestones set in the Contract and the dates in the CIP and as agreed with the other contractors and/or Indian Railways.

(8) The Contractor shall undertake a lead role in the co-ordination of the activities associated with integrated systems testing including the co-ordination of other contractors and/or Indian Railways to test and monitor their systems to prove the design and integrity of the systems as a whole.

(9) It shall be the responsibility of the Contractor to secure from the other contractor(s) and/or Indian Railways, in a timely and correct manner as per the agreed CIP, whatever interface provision is required for the Contractor to carry out its duties under the Contract.

(10) Any additional cost arising to the Contractor due to his late and/or improper interfacing with the other contractors and/or Indian Railways, shall be to the Contractor's account. Such improper interfacing shall include, but not be limited to:

a. Late provision of interfacing information

b. Failure to adhere to agreed interface

c. Changing an interface after it has already been agreed and signed off

(End of Chapter 10)

CHAPTER 11 - QUALITY ASSURANCE AND MANAGEMENT

11.1 GENERAL

11.1.1 The Contractor shall maintain and implement a quality assurance and management system that shall remain in effect during the execution of the Works. The Contractor's quality assurance and management system shall be tailored specifically to the Contract and the Works in accordance with ISO 9001 – Quality Management System, the latest edition of the International Standard ISO 9001, and the Contractor shall submit his quality management system titled as the Project Quality Assurance Plan for Engineer's review as specified herein.

11.1.2 The Project Quality Assurance Plan documentation shall include, but shall not be limited to the following:

(1) Project Quality Assurance Plan (Contractor's Integrated Quality assurance documentation);

(2) Design Quality Assurance Plan;

(3) Site Quality Assurance Plan (including Inspection and Test Plan);

(4) Manufacturing Quality Assurance Plans (including Inspection and Test Plan); and

(5) On-site Inspection Plan for Resources Procurement;

11.1.3 The Contractor shall plan, perform and record all quality control activities to ensure that all Works are performed in accordance with the requirements under the Contract and are detailed in the quality plans which are required herein. Such activities shall include, without limitation, the inspections and/or test expressly or implicitly required by the Contract.

11.1.4 Quality audits will be carried out by the Engineer and surveillance audit shall be carried out by Employer to verify the Contractor's implementation and compliance with the quality management system as specified herein.

11.2 SUBMISSION OF QUALITY DOCUMENTATION

11.2.1 Quality system documents to be submitted shall embrace all activities of the Contractor and his Sub-Contractors of any tier including his suppliers and any design consultants for the execution of the Works.

11.2.2 The Contractor shall prepare and submit the following documents for review by the Engineer:

(1) Contractor's Quality Assurance Philosophy;

(2) Project Quality Assurance Plan; and

(3) Design Quality Assurance Plan and any associated work instruction and/or standard forms which the Contractor proposes to be used for the Contract.

11.2.3 The Contractor shall submit separate Site Quality Assurance Plan and Manufacturing Quality Assurance Plans for managing, controlling and recording the on-site construction and manufacturing process including off-site process for individual key items of the Works. The Manufacturing Quality Assurance Plan shall be submitted for review by the Engineer for his consent as part of Detailed Design development as described in Chapter

8: "Supply, Installation, Testing & Commissioning".

11.2.4 The Contractor shall submit separate On-site Inspection Plan for Resources Procurement for managing, monitoring and recording the on-site receipt of general construction resources including all construction material, labour force and works and services delivered to the construction site. The On-site Inspection Plan for Resources Procurement shall be submitted for consent by the Engineer.

11.2.5 The Contractor shall continuously review and update the quality system documents to meet the requirements and development of the Works throughout the duration of the Contract. For any amendment to the quality system documents, the Contractor shall prepare and submit the proposed amendment for consent of the Engineer.

11.2.6 The Plan shall clearly define the Contractor's policy, Quality Assurance Organization, Management responsibility, the requirements for Quality Assurance personnel, their qualifications, skills and training, the Contractor's Quality Audit schedule.

11.2.7 Records of certifications shall be maintained and monitored by the Quality Assurance personnel. These records shall be made available to the Engineer / Employer for inspection and review as and when required.

11.2.8 The Quality Assurance operations shall be subject to the Engineer's verification at any time. The verification will include: surveillance of the operations to determine that practices, methods and procedures of the plan are being properly applied; inspection to measure quality of items to be offered for acceptance; and audits to ensure compliance with the Contract documents.

11.2.9 The Contractor's Quality Audit schedule shall be submitted to the Engineer for consent every three months or more frequently as required.

11.2.10 The Contractor shall provide all necessary access, assistance and facilities to enable the Engineer / Employer to carry out on-site and off-site Quality Audit / surveillance audit to verify that the Contractor's quality assurance system which has been consented by the Engineer is being implemented fully and properly.

11.3 CONTROLLED COPY OF QUALITY SYSTEM DOCUMENTATION

The Contractor shall promptly supply the Engineer with six (6) controlled copies of his quality system documents duly consented by the Engineer. The Contractor shall maintain such controlled documents throughout the duration of the Contract. In addition, the Engineer may request further copies of the quality system documents and these documents shall reach to the Engineer office within Fourteen (14) days of notification.

11.4 PROJECT QUALITY ASSURANCE PLAN

11.4.1 The Project Quality Assurance Plan shall establish the Contractor's management structure which functions efficiently to execute the Works in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(1) A dedicated Quality Assurance Team;

(2) Appointment of a Senior Design Engineer and a Quality Assurance Engineer as described hereinafter;

(3) A set of organization charts which depict in line with the Contractor's intent of the quality plans. Each organization chart shall identify the Contractor's managerial

staff with reference to any member of the partnership, consortium or joint venture, and the main Sub-Contractors and indicate the reporting structure and the interface relationship between all parties involved;

(4) Each organization chart which may be subdivided with regard to Works segments, site locations, and phases and stages of the project to ensure complete implementation of the quality management system in every part to the Work;

(5) The Allocation of responsibilities and authorities given to managerial and technical staff with particular reference to the design and site supervision of the Works; and

(6) Hierarchy of the quality management system documentation for managing and controlling the whole system.

11.4.2 The Contractor shall submit the Curriculum Vitae (CV) of each member of his Quality Assurance Team and other personnel relevant to his quality management system. Assignment of such personnel shall be subject to prior consent of the Engineer,

11.4.3 The Project Quality Assurance Plan shall without limitation include Quality Assurance procedures for design, construction, manufacturing, supply, installation, testing and commissioning and shall contain control processes for each stage in the Work such as design verification and validation, management of change control, non-conformance procedures, control on sub-standard practices, inspection, testing, auditing and so on.

11.4.4 The Project Quality Assurance Plan shall also include a full list of quality management procedures, method statements, inspection and test plans, standards and protocol and/or standard forms which shall form the frame work of the Project Quality Assurance Plan. It shall define specific procedures to perform the quality management activities and to record the evidence of the activities performed and/or the results achieved. It shall detail the system and the procedure by which the Contractor shall ensure that

(1) The Quality Assurance Plan is fully observed at all times and

(2) Any non-compliant and sub-standard material, practice and / or work are brought back to compliance.

11.4.5 It shall cover the requirements of the International Standard ISO 9001 in compliance with the Contract as precedence requirements and shall, without limitation, include the basic management disciplines as follows:

(1) Review, approval and updating management of the quality system documents to ensure their continuing suitability and effectiveness;

(2) Design control management to all Permanent Works and/or Temporary Works including design works carried out by Sub-Contractors and sub-consultants. The procedures shall clearly define the review and verification procedures of the designs submittals and the design packages described under the Contract;

(3) Drawing management in the Contractor's main office and site office(s), including procedures of production, approval, updating, maintaining, storage and distribution;

(4) Document management including procedures of registration, updating, indexing, filing, maintenance, storage and distribution and monitoring and recording of the submission and re-submission to the Engineer;

(5) Monitoring, recording and control of the quality system of his Sub-Contractors with respect to their quality of works with relevant time schedule; and

(6) Quality control of the Works including Quality audits to be held on the Contractor and Sub-Contractors, suppliers and design consultants of any tiers.

11.5 DESIGN QUALITY ASSURANCE PLAN

The Contractor shall prepare the Design Quality Assurance Plan separately for its design Works. The Design Quality Assurance Plan shall establish the Contractor's policy for the design works in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(1) Organization of the Contractor's Design Team in context with the Contractor's entire organization so as that it functions appropriately in this Design-Build Lump Sum Contract;

(2) Allocation of responsibilities and authorities to be given to the Design Team, to the individual identified design staff and the Subcontractors for particular design works especially the Internal Authorization Process as detailed herein;

(3) Hierarchy of relevant documentation (including drawings) of quality management system for managing and controlling design works including design works of Subcontractors of any tier to avoid conflicts in the design submissions;

(4) A list of general procedures to be applied to manage and control the quality of the design works and

(5) The Functional procedures which maintains the Design Team in whole Contractor's organization to carry out the design works strictly in compliance with the Employer's Requirements and for the benefit of the Employer.

11.6 DESIGN REVIEW

11.6.1 Contractor's Design Team

(1) The Contractor shall be responsible for the design of the Works and shall ensure his design is correct / accurate and in compliance with the Employer's Requirements and Specifications contained in the Contract. The Contractor shall ensure that all the completed Works are in line with his design and concurrently in compliance with the Employer's Requirements and safe.

(2) The Contractor shall establish his dedicated design team referred to as the Design Team in his organization to ensure that his design works are strictly in compliance with the Employer's Requirements and Specifications and for the benefit of the Employer. On the other hand, to clarify the responsibilities and the authorities, the Contractor shall also establish a Construction Team independent of the Design Team; thereby the Contractor shall be responsible for assuring the quality of the Works as required in the relevant Particular Specifications.

11.6.2 Senior Design Engineer

(1) The Contractor shall appoint a fully qualified and experienced full-time Senior Design Engineer whose credentials has been submitted by the Contractor as part of his Technical proposal and has been accepted by the Engineer. The Senior Design Engineer shall act as a representative of Design Team and shall be wholly responsible for the Contractor's design Works.

(2) The Senior Design Engineer shall be responsible for establishing, implementing,

maintaining and recording Design Quality Assurance Plan.

(3) The Senior Design Engineer shall be able to discharge his duties without any hindrance or constraint. Accordingly, the Senior Design Engineer and his team shall strictly adhere to ISO 9001–Quality Assurance System of the Contractors, as consented by the Engineer so as to ensure that his decisions and activities with regard to the Quality Assurance be checked and monitored by the internationally acknowledged system. The Contractor shall identify the personnel to whom the Senior Design Engineer shall be responsible and reports to and seek the consent of the Engineer for the same. The Contractor shall also identify personnel necessary under the supervision of the Senior Design Engineer to furnish the Design Team to fully function as intended in the requirements herein and seek the consent of the Engineer. In addition, the Contractor shall make available any such resources that are necessary to ensure the effective implementation of the quality management system.

(4) The Contractor shall submit details of the authority and responsibility of the proposed Chief Design Engineer for review and consent by the Engineer, as part of the Project Quality Assurance Plan.

11.7 INTERNAL AUTHORIZATION PROCESS

11.7.1 All design submissions including Detailed Design, Construction Design, As-Built Documents shall include a valid "Design Certificate" as per GS Chapter-15, Appendix-3: "Design Certificates" duly signed by Chief Design Engineer in the Contractor's Design Team and Contractor's authorized Representative, thereby demonstrating that:

(1) Design of the Permanent Works complies with the relevant Particular Specifications

(2) In-house checks have been undertaken to conform the completeness, adequacy and validity of the design as per all the quality assurance procedures

(3) All the required approvals has been obtained

(4) Design has been performed and finalized utilizing the skills of a professionally qualified, competent and experienced designers and engineer(s)

11.7.2 The Contractor shall fully verify the respective design outputs as a set of submissions through the Internal Authorization Process by signing and attaching "Design Certificate" as the covering document. Forms, further details and other requirements of the contents of the respective Design Package are detailed in Employer's Requirement, GS, Part 2, Section VII-1,

11.7.3 After receiving the "Notice of No Objection' or "Notice of No Objection with Comments" in respect of the Construction Design, all the original paper drawings in respect of Working Drawings shall be endorsed as "Good For Construction" by Senior Design Engineer before issuing it to the Site or submitting to the Engineer for his endorsement as specified in GS, Chapter-3: "Project Planning & Management".

11.7.4 In case the Contractor contemplates any change in the design already submitted to the Engineer for approval and / or for the design and drawings for which the Contractor has already received 'Notice Of No Objection', it shall be dealt as per the provisions of Design Review Procedure detailed in the preceding para.

11.8 SITE QUALITY PLAN

11.8.1 On-site Quality Management Provisions

The Contractor shall prepare a Site Quality Plan separately for the construction and installation of Works. The Site Quality Plan shall include the comprehensive on-site quality management in compliance with the Employer’s Requirements under the Contract and shall, without limitation, define as follows:

(1) Organization of the Contractor’s staff directly responsible for the day-to-day management of the construction and installation activities to execute the Works on the site;

(2) Allocation of responsibilities and authorities given to identified personnel or Subcontractors for particular construction and installation of the Works;

(3) Hierarchy of relevant documentation (including drawings) of quality management system for managing and controlling construction and installation of the Works including construction and installation works of Subcontractors of any tier to avoid conflicts in the execution of the Works; and

(4) A list of sequences to be applied to manage, control and record the construction and installation of the Works.

11.8.2 On-site inspection and test provisions

(1) The Contractor shall also prepare onsite inspection and test plans to manage, control and record any test and inspection activities. The Inspection and Test Plans shall be established for particular activities which require inspection and/or test to meet the quality level required in the Employer’s Requirements and as included in any form in the Contractor’s design and the Works Specifications. It shall cover the requirements of International Standards ISO 9001 and in compliance with the Contract

(2) The Contractor shall prepare and maintain a full list of the all Inspection and Test Plans needed under the Contract with submission status and review status and shall submit to the Engineer for his consent.

(3) Each Inspection and Test Plan for the particular activity shall define, without limitation:

i Scope of activities covered by the plan;

ii A sequence of the Work related to the activities in the scope;

iii Personnel responsible for undertaking the inspections and/or tests and the personnel responsible for certifying the inspections and tests;

iv Inspections and/or test methods, their frequency, and/or reference material to the relevant standard of the inspections and/or the tests;

v Compliance criteria of the inspections and/or tests with clear descriptions of the quality hold point and the quality control point;

vi Documents to be used for reporting the results of the inspections and/or tests with sample documents incorporated into the Plan; and

vii Methods of record keeping and document storage as to the locations to be maintained / stored and procedures for those to be acknowledged / filed.

11.9 MANUFACTURING MANAGEMENT AND QUALITY ASSURANCE PLANS

11.9.1 Manufacturing Quality Management Provisions

The Manufacturing Quality Plans shall define the Contractor's management structure and quality management system for the manufacturing process of the key items of the Works and for the items as requested by the Engineer. Separate Manufacturing Quality Assurance Plans shall be prepared for each manufactured item and submit them to the Engineer for consent. Each Manufacturing Quality Assurance Plans for manufacturing process management shall be established in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(1) Scope of activities and items covered by the plan;

(2) Organization of the Contractor and/or the Subcontractor responsible for the day to day management of the manufacturing process of the items;

(3) Allocation of responsibility and authority given to identified personnel for the day to day management of the manufacturing process with particular reference to the supervision, inspection and testing of the process and manufactured items;

(4) Specific methods including handling and management of the manufacturing process and manufactured items, including but not limited to the following:

a. Particulars of the material to be used in the manufacturing process;

b. Monitoring and management of manufacturing process in compliance with the approved drawings and specifications;

c. Identification or referencing procedures for traceability of the manufactured date;

d. Identification of the inspection/ test status of the material and the final manufactured item;

e. Disposition of nonconforming material and the manufactured item;

f. Handling, storage, packaging, preservation and delivery of the manufactured item; and

g. Procedure of monitoring and recording of the ordering and delivery of the item.

11.9.2 Manufacturing inspection and test provisions

(1) The manufacturing inspection and test plans to be prepared by the Contractor shall cover all the requirements of Tests: Type Tests(wherever applicable), Factory Acceptance Tests, site checks and tests, Installation Tests, System Acceptance Tests and tests on completion as required.

(2) The inspection is to be conducted by the contractor and witnessed by the Engineer and/or the Employer representative. The Employer may, at his own cost, depute its representative or nominate any other independent inspection agency (in addition or as replacement) for supervising, monitoring and inspection of raw material and manufacturing process at the factory. In order to facilitate such an inspection, the detailed production/manufacturing plan shall be provided by the Contractor to the participants of the inspection as well as to the Engineer at least six weeks in

advance of the commencement of the manufacturing process along with the description of mandatory specifications and tests proposed during the manufacturing process and the tests intended to be conducted on the finished product along with codal permitted tolerances.

11.10 ON-SITE INSPECTION PLAN FOR RESOURCES PROCUREMENT

11.10.1 The Contractor shall establish On-site Inspection Plan for Resources Procurement for managing, monitoring and recording the on-site receipt of general construction resources including all construction material, labour forces, and works and services delivered to the Site and the Temporary Facilities e.g. assembly and tests on assemblies prior to installation, their stacking and storage etc. in the Work Areas.

11.1.1 Onsite Inspection Plan for resources procurement to be prepared by the Contractor shall cover all the requirements.

11.11 TESTS

11.11.1 Tests to be carried out for quality assurance purposes shall be as specified in the Particular Specifications and as per the Quality Assurance Plan / Inspections and Test Procedures duly approved by the Engineer.

11.11.2 The Contractor may employ other tests to further ensure the quality of the Works. In such a case, the Contractor shall be responsible for obtaining prior approval from the Engineer by submitting the test plans with regard to the application of the tests as part of the Project Quality Assurance Plan or its sub-plans.

11.11.3 Test Plan and Procedure

The Contractor shall submit all test plans and procedures for review by the Engineer at least 30 days prior to conducting any test together with the exact time and date of such tests. Test procedures shall show the following unambiguously but shall not be limited to:-

(1) List of resources required to carry out the various testing activities and their capabilities.

(2) Date on which the Contractor proposes to conduct each of these listed tests;

(3) nature and purpose of test;

(4) extent of testing covered by each submission;

(5) method of testing and tests requirements with the relevant standards;

(6) relevant drawing and document (or modification) status;

(7) location of testing;

(8) test parameters to be measured with the relevant standards;

(9) constraints to be applied during the test with the relevant standards;

(10) defined pass/fail criteria with relevant standards;

(11) format of the raw data for processing by the Contractor; and

(12) test instrumentation and test circuitry to be used during the test with the relevant standards.

11.12 QUALITY AUDITS

11.12.1 The Contractor shall carry out quality audits on the Works at quarterly intervals or at such other intervals as the Engineer may require, ensuring the continuing suitability and effectiveness of the quality management system. Reports of each such audit shall be submitted promptly to the Engineer for review.

11.12.2 The Contractor shall submit, for review by the Engineer, details of the authority, qualifications and experience of personnel assigned to quality audit activities before carrying out quality audits.

11.12.3 The Engineer may require quality audits on the Contractor and his Subcontractors to be carried out by his representative or the Employer's staff. In such case, the Contractor shall afford to such auditors all necessary facilities and access to the activities and records to permit this function to be performed.

11.12.4 Upon receipt of corrective action request (CAR) or similar document issued by the Engineer as a result of quality audits, the Contractor shall promptly investigate the matter and submit the proposed corrective and preventive actions within 14 days to the Engineer for review. The Contractor shall take timely corrective and preventive actions to rectify the matter and to prevent re-occurrence. Evidence to demonstrate effective implementation of corrective and preventive actions shall be submitted by the Contractor to the Engineer for review.

11.13 NOTIFICATION OF NON-CONFORMITIES

11.13.1 If, prior to an issue of the Taking-Over Certificate for the Works or the relevant Section, the Contractor proposes to repair any item of the Works which does not conform to the requirements of the Contract, the Contractor shall immediately submit for review by the Engineer of such proposal and supplying full particulars of the nonconformity and, if appropriate, of the proposed means of repair.

11.13.2 If the Engineer issues nonconformity report or similar documents to notify the Contractor of any item of the Works which does not conform to the requirements of the Contract, the Contractor shall promptly investigate the matter and within 14 days of notification by the Engineer, submit to the Engineer for review the remedial measures and necessary actions to be taken to rectify the item and to prevent re-occurrence.

11.13.3 The Contractor shall maintain and update a nonconformity register to indicate the status of all nonconformities which are identified by the Engineer/ and or the Contractor. The Contractor shall submit the register for review upon request by the Engineer.

11.14 MONTHLY PROGRESS REPORT ON QUALITY MANAGEMENT SYSTEM

11.14.1 The Contractor shall continuously monitor the performance of the quality management system and shall include the same in each Monthly Progress Report.

11.14.2 The Contractor shall provide and maintain, at all stages of the Works, a quality control register(s) to identify the status of inspections, sampling and testing of the work and all certificates. Such register shall be updated by the Contractor to show all activities in previous months and shall reach the Engineer's office before 7th working day of each month. Each register shall:

(1) List the certificates received for each batch of goods and material incorporated in

the Works and compare this against the certification required by the Contractor and the Contractor's quality plans;

(2) List the inspection and testing activities undertaken by the Contractor on each element or segment of the Works and compare these activities against the amount of inspection and testing required by the Contract and the Contractor's quality plans;

(3) Show the results of each report of inspection and/or test and any required analysis of these results and compare these results against the pass/fail criteria;

(4) Summaries any actions proposed by the Contractor to overcome any nonconformity; and

(1) The Engineer shall submit the same to the Employer along with his observations / comments before 15th working day of each month.

11.15 QUALITY RECORDS

The Contractor shall ensure that all the quality records as objective evidence of the implementation of the quality management system are properly indexed, filed, maintained, updated and securely stored.

(End of Chapter 11)

CHAPTER 12 - RELIABILITY, AVAILABILITY, MAINTAINABILITY & SAFETY (RAMS)

12.1 GENERAL

12.1.1 The Reliability, Availability, Maintainability, & Safety activities shall be undertaken throughout the whole course of the project as an Integral part of System Assurance in order to demonstrate in a logical, progressive and traceable manner that:

(1) The objectives and requirements of the project have been satisfied.

(2) All systems and components of the works are defined appropriately with verifiable performance benchmarks.

(3) Proper designs, Calculations and Simulation tools have been used.

(4) The work has been executed by suitably competent people.

(5) The designs have been verified by the competent authorities.

(6) Any manufacturing, construction, installation, testing and commissioning works associated with the project have been validated.

(7) Safety related aspects of the systems have been identified, analyzed and mitigated such that residual risks have been demonstrated to be as low as reasonably practicable for all project stages.

(8) RAMS requirements of the Systems have been identified, apportioned to various subsystems and elements of the works and the associated designs for these have been demonstrated to be capable of meeting their allocated performance targets.

12.1.2 The activities shall apply to software design as well as hardware and hardware application designs.

12.1.3 The Contractor shall co-ordinate results of analysis with each engineering discipline, particularly as the results affect engineering and hardware development.

12.1.4 The Contractor shall make recommendations for reengineering or modifications necessary to assure compliance with specified requirements including redundancy, utilization of high reliability components, built-in self-diagnostics and "self-healing"; utilization of in-service status displays to enhance fault isolation and test; easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

12.1.5 The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

12.1.6 The Contractor shall maintain documentation of System Assurance throughout the engineering and make it available for examination.

12.2 SYSTEM ASSURANCE PLAN / RAMS PLAN

12.2.1 The System Assurance / RAMS Plan shall be maintained as a live document and updated as necessary throughout the duration of the Project.

12.2.2 The System Assurance plan shall define the Contractor's approach on systematic Compliance to System Requirement Specifications, procedures and schedules for conducting the Reliability, Availability, Maintainability and Safety Engineering. Human Factors Engineering is an integral part of System Assurance and shall be considered and reflected within the System Assurance Plan.

12.2.3 System Assurance Plan shall describe the organization, resources and procedures that will be established to manage system assurance activities.

12.2.4 This System Assurance Plan will describe the RAM and Safety Assurance activities throughout the project lifecycle, comprising:

(1) Preliminary Design

(2) Detailed Design

(3) Final Design

(4) Manufacturing and Production

(5) Testing and Commissioning

(6) Operation

12.2.5 The Contractor shall liaise with the Employer/Engineer to establish a comprehensive program of work that will encompass all the requirements of this plan in a time scale that enables the construction, installation, test, commissioning, putting to work and warranty monitoring to be undertaken in good time to meet the overall time scales of the project.

12.2.6 The Contractor shall submit a compliance matrix in the Assurance Plan with all phases mentioned above and tasks to be performed and the deliverables to be submitted. These requirements shall also be applied to sub-contractors.

12.2.7 The System Assurance Plan as a minimum, shall include:

(1) Organizing the System Assurance Plan to include the System requirement and obligations towards Safety, Reliability, Availability and Maintainability engineering.

(2) Describing the procedures to perform the specific RAMS tasks necessary to meet Safety, Reliability, Availability and Maintainability requirements.

(3) Describing the system assurance organization which includes RAM and Safety organization.

(4) Clearly defining the responsibilities of personnel directly associated with system assurance activities and implementation of the Program.

(5) Application of the relevant standards, Indian Railways (IR) standards, norms, regulations, instructions and the Employer's Requirements / Specifications.

(6) Demonstration of compliance with RAMS requirements.

12.2.8 The System Assurance Plan shall also include, the following:

(1) Scope and purpose of Compliance Management.

(2) Scope and purpose of Verification & Validation.

12.3 COMPLIANCE MANAGEMENT

12.3.1 A compliance management process shall be established and maintained for the duration of the Project to:

(1) Import all RAMS requirements from the Project documents and ensure compliance to Technical Specifications and System Requirements Specifications.

(2) Import design requirements and specifications from each stage of design as they are developed and assess the impact of any changes in these.

(3) Provide traceability to demonstrate that high level and low level design requirements and specifications have been verified that they satisfy the RAMS requirements.

(4) Provide traceability of review comments made and the associated responses and follow up actions.

(5) Provide traceability of non-conformances and follow up actions required to address them.

(6) Provide traceability of validation of testing and commissioning results against RAMS requirements or design requirements and specifications.

(7) Provide summary reports on key status items including, but not limited to requirements not yet satisfied and incomplete or missing verifications or validations.

12.4 VERIFICATION & VALIDATION

12.4.1 Verification and validation activities shall be undertaken to show in a logical, progressive and traceable manner that the:

(1) The designs satisfy the RAMS requirements.

(2) The completed works that have been subjected to testing and commissioning indeed demonstrate that they meet the RAMS requirements.

12.4.2 Verification & Validation shall be carried out preferably by an engineering team who are independent from those carrying out the design.

12.4.3 All the equipment & components/ Products used in the Contract shall be approved only when the Engineer has been satisfied as to their strength, reliability and suitability. To assist the Engineer in this respect, the Contractor shall furnish on request, performance data, references to completed works and any other relevant information together with samples of materials for approval.

12.4.4 Verification methods shall include one or more of the following:

(1) Analysis of design

(2) RAM studies

(3) Design safety studies

(4) Simulations

(5) Calculations

(6) Benchmarking against international best practice where appropriate, and

(7) Other methods as appropriate.

12.4.5 Records of all verification and validation activities shall be kept and shall be traceable through the Compliance Management Process.

12.5 SYSTEM ASSURANCE / RAMS ORGANIZATION

12.5.1 The System Assurance organization of the contractor shall have dedicated RAM and Safety Managers who shall have implemented the RAMS strategy for the relevant system in at least one Metro/railway project environment.

12.5.2 Alternately, the Contractor can engage the services of a RAMS consultant to manage the entire scope of the RAMS work.

12.5.3 In the event that Employer engages the services of an Independent Assessor, the Contractor shall coordinate with the Independent Assessor and provide all documentation requested.

12.6 RELEVANT STANDARDS

12.6.1 The RAMS Assurance activities shall comply with the requirements of EN 50126: Railway Application – The specification and demonstration of reliability, availability, maintainability and safety (RAMS) or the equivalent IEC 62278 standards.

12.6.2 RAMS assurance activities related specifically to communications, signalling and processing systems shall comply with the requirements of:

(1) EN 50128: Railway Application – Communications, signalling, and processing systems – Software for Railway control and protection Systems.

(2) EN 50129: Railway Application – Communications, signalling, and processing systems – Safety related electronic systems for signalling or the equivalent IEC 62279 and IEC 62280 standards.

12.6.3 Apart from the above mentioned mandatory standards, it is recommended to follow the below mentioned standards of the latest edition.

(1) IEC 61025: Fault Tree Analysis

(2) IEC 61078: Analysis techniques for dependability: Reliability block diagram and Boolean methods

(3) IEC 60812: Analysis techniques for system reliability – Procedure for failure modes and effects analysis (FMEA)

(4) MIL-STD-1629A: Procedure for performing a Failure Mode Effect and Criticality Analysis (FMECA)

(5) MIL STD 471-A: Maintainability Verification / Demonstration / Evaluation

(6) IEC 60300-3-5: Dependability management - Part 3-5: Application guide – Reliability test conditions and statistical test principles.

(7) IEC 60300-1: Dependability management — Part 1: Dependability management systems

(8) IEC 60300-2: Dependability management - Part 2: Guidelines for dependability management.

(9) BS EN 50562:2018: Railway applications. Fixed installations. Process, protective measures and demonstration of safety for electric traction systems.

12.7 LIST OF DEFINITIONS

12.7.1 In this document, following defined terms shall have the meanings as described here below:

Definitions	Descriptions
apportionment	process whereby the RAMS elements for a system are sub-divided between the various items which comprise the system to provide individual targets
assessment	undertaking of an investigation in order to arrive at a judgment, based on evidence, of the suitability of a product
availability	ability of a product to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided
Compliance	Demonstration that a characteristic or property of a product satisfies the stated requirements.
Corrective Maintenance	maintenance carried out after fault recognition and intended to put a product into a state in which it can perform a required function
down time	time interval during which a product is in a down state
Failure mode	predicted or observed results of a failure cause on a stated item in relation to the operating conditions at the time of the failure
Fault tree analysis	analysis to determine which fault modes of the product, sub-products or external events, or combinations thereof, may result in a stated fault mode of the product, presented in the form of a fault tree
hazard	physical situation with a potential for human injury and/or damage to environment
Hazard log	Document in which all safety management activities, hazards identified, decisions made and solutions adopted are recorded or referenced. Also known as a "Safety Log"
maintainability	probability that a given active maintenance action, for an item under given conditions of use can be carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources
preventive maintenance	maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item
reliability	probability that an item can perform a required function under given conditions for a given time interval ($t1$, $t2$)
Reliability growth	condition characterized by a progressive improvement of a reliability performance measure of an item with time
repair	that part of a corrective maintenance in which manual actions are performed on the item

restoration	that event when the item regains the ability to perform a required function after a fault
Risk	probable rate of occurrence of a hazard causing harm and the degree of severity of the harm
safety	freedom from unacceptable risk of harm
safety case	documented demonstration that the product complies with the specified safety requirements
safety integrity	likelihood of a system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time
safety integrity level (SIL)	One of a number of defined discrete levels for specifying the safety integrity requirements of the safety functions to be allocated to the safety related systems. Safety Integrity Level with the highest figure has the highest level of safety integrity
Safety-Critical	Failure of the system, sub-system or equipment will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.
Tolerable risk	maximum level of risk of a product that is acceptable to the Railway Authority
Validation	confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled
Verification	Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled.

12.8 SYSTEM RAM MANAGEMENT

12.8.1 RAM Management Activities

(1) **Design Phase -** The RAM Management activities shall include:

a. Preparation of RAM Plan

b. Develop RAM allocations for subsystems, assemblies, and equipment.

c. Perform Reliability, Maintainability and Availability analyses at the Preliminary Design phase.

d. Perform detailed Reliability, Maintainability and Availability analyses and Prediction at the Final Design phase.

e. Perform FMECA

f. Integrate RAM design and analysis results into test planning, maintenance planning, maintenance manuals, and operating manuals.

g. Establish FRACAS

(2) **Construction and Installation Phase - The RAM activities shall include:**

a. Updating of Reliability, Maintainability and Availability analyses and Prediction

b. Updating FMECA

c. Preparation of Reliability, Maintainability and Availability Demonstration Plans

(3) **Testing, Trials and Warranty Phase - The RAM activities shall include:**

a. Perform RAM Demonstration.

b. Execute a Failure Reporting and Corrective Action System (FRACAS).

c. Provide all necessary reports and documentation for tracking by the V&V process.

12.8.2 RAM Plan

RAM Management activities shall be undertaken in order to demonstrate in a logical, progressive and traceable manner that the works satisfy the requirements of the project pertaining to RAM. The objectives of the System RAM Plan are to:

(1) Define RAM Program scope, tasks, techniques, deliverables, and milestones.

(2) Provide a RAM Program schedule, which identifies specific tasks, with start and completion dates, and explains how these tasks are coordinated and integrated with major program milestones during design, manufacturing, and testing stages.

(3) Provide the organization of personnel responsible for performing the RAM Program.

(4) State methodology to predict compliance with the RAM requirements.

(5) Provide demonstration testing plans for verification of compliance with RAM requirements.

(6) Describe monitoring and control of subcontractors and suppliers.

(7) Define interfaces to and coordination with other system assurance activities such as system safety, design, procurement, and quality assurance.

12.8.3 RAM Analysis and Prediction

(1) Contractor shall undertake a RAM Analysis and Prediction of the system. The RAM Analysis will provide an initial and broad assessment of all known service failure and service interruption modes for top-level events such as minor, major, and immobilizing service interruptions.

(2) The purpose of the RAM Analysis is to ensure that the potential service failure modes, causes, and mitigations are well understood by all parties as the design, integration, fabrication, testing, and acceptance activities move forward.

(3) Reliability shall be assessed in terms of the MTBF/MTBSAF. The assessment will have a bottom up approach commencing from the LRU level and proceeding up to the sub-system and system level. MTBF/MTBSAF is the predicted elapsed time between inherent failures/service affecting failures of a system during operation.

(4) The RAM Analysis shall also be used to identify and select service failures for in-depth assessment in the Fault Tree Analysis (FTA).

(5) The Contractor will provide a first iteration of the Reliability Prediction Report for employer's approval. Reliability Prediction Report will be periodically updated until the task is concluded.

(6) Reliability Predictions shall be conducted at the appropriate level of detail to ensure adequate reliability and fulfilment of the specifications and RAM

requirements. This may entail conducting an analysis at the subsystem, assembly, lowest replaceable unit (LRU), block, element, or component level, and may require combining differing analyses from different levels for a single subsystem.

(7) Reliability Predictions shall be based on existing performance records, reliability test data, warranty and operating data, and reliability prediction analyses from previous similar projects. For equipment with incomplete or inconclusive operating, failure, and/or reliability demonstration data, the equipment supplier will develop a reliability prediction using other information sources, such as, MIL-HDBK-217F Notice 2, Non electronic Parts Reliability Data (NPRD), Manufacturer test data, or any other well-established industrial reliability prediction databases.

(8) The reliability predictions shall be subject to confirmation during the Reliability Demonstration Test.

12.8.4 Failure Mode, Effects, and Criticality Analysis (FMECA)

FMECA is a systematic procedure for the analysis of a system to identify the probability of occurrence and severity of the potential failure modes, their respective causes and immediate and final effects on systems performance (performance of the immediate assembly and their entire system) and to provide an input to mitigating measures to reduce risk.

(1) FMECA shall be performed and updated at different project stages until the task is concluded. The FMECA will be intended to:

a. Undertake decomposition of the System, Sub-systems from the highest level till the LRU level.

b. Provide the lowest-level analysis of failures and failure effects on the system and its subsystems and equipment.

c. Identify weaknesses in system hardware and software design and analyse failure modes and effects, particularly for when these details are not established by historical records of equipment operation.

d. Use inductive logic in a "bottom up" system analysis. This approach begins at the lowest level which is the Lowest Replaceable Unit (LRU) of the equipment under analysis and traces consequences up to the system level to determine the end effects on sub-system and system performance.

e. Identification of single failure points critical to proper system performance.

f. Provide early visibility into potential system interface problems.

g. Perform Criticality Analysis (CA) of the list of possible failure modes by ranking them in accordance to their risk which is dependent on the probability of occurrence and severity of the failure. The CA will allow prioritization of mitigation measures.

(2) The purpose of FMECA shall be to identify:

a. Those failures which have unwanted effects on safety

b. Those failures which have unwanted effects on system operation

c. Those failures which have unwanted effects on overall reliability

d. To allow improvements of the systems safety

e. To allow improvements of the systems reliability

f. To allow improvement of the systems maintainability

g. To allow improvements in the systems availability

12.8.5 Reliability Critical Item List (RCIL)

(1) The contractor shall perform Reliability Analysis to identify Reliability Critical Items List (RCIL). Reliability critical items are those items that have a significant impact on product reliability, performance, safety, availability or life cycle cost. Identifying and controlling critical items is imperative since these parts are often the parts that drive unreliability.

(2) A critical item output report will be submitted to ensure that reliability critical components were identified and controlled; reliability predictions and an FMECA were performed. Critical items will be identified via the failure rates noted in the prediction and by the single failure point analysis performed in the FMECA.

12.8.6 Maintainability Analysis and Predictions

(1) The contractor shall perform analytical maintainability analysis and prediction to assure compliance with the specific maintainability requirements and to ensure system performance.

(2) Maintainability shall be assessed in terms of MTTR. The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including software re-boot, up to the point the system is restored to full functionality.

(3) The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

(4) In all availability calculations the following access times shall be assumed:

a. 30 minutes for train-borne equipment.

b. 1 hour for track side.

c. 30 minutes for equipment located in equipment rooms.

d. 1 hour for Signalling equipment.

e. 2 hours for Telecom equipment.

(5) In the maintainability analysis, the contractor shall lay special emphasis on features such as Built-in-Test (BIT) and fault isolation, acknowledging the criticality of these features to the effectiveness of system testability and maintainability. Built-in-Testing goals should be established that provide the attainment of highest fault coverage detection and isolation to the Lowest Replaceable Units (LRUs).

(6) The contractor shall perform Maintainability Analysis to identify Maintainability Critical Items List (MCIL). The maintainability critical items are those items that have a significant impact on product maintainability, performance, availability or life cycle cost. Identifying and controlling critical items is imperative since these parts are often the parts that drive system downtime.

12.9 SYSTEM SAFETY MANAGEMENT

12.9.1 Principle of Safety Management

(1) System Safety Management activities shall be undertaken to demonstrate in a logical, progressive and traceable manner that the works satisfy the safety requirements of the Project.

(2) The basic principle of safety management shall be that all reasonably foreseeable hazards are identified and action then taken for each hazard as follows:

a. Risks arising from the hazard shall be assessed.

b. If the risk is broadly acceptable no further action shall be required, otherwise measures shall be taken to reduce or eliminate the risk.

c. Each of these measures shall become a 'safety requirement' and all safety requirements shall be subject to verification and validation processes to show that they have been met by design and later by practical tests.

d. The mitigation, verification and validation status of all hazards shall be recorded in the Hazard Log.

12.9.2 System Safety Plan

The System Safety Plan shall be developed in accordance with EN 50126 and shall include but not be limited to the following subjects:

(1) Safety policy;

(2) Risk acceptance criteria;

(3) Risk management and Principles;

(4) Hazard Analysis and Hazard Log;

(5) Design safety studies; and

(6) Management of safety during integrated testing, trials, and commercial operation.

12.9.3 Safety Policy

The proposed approach and commitment to safety shall be specified in a statement of safety policy endorsed by the submitter's senior management and this statement shall be included in the System Safety Plan.

12.9.4 Risk Acceptance Criteria

(1) Risk is defined as probable rate of occurrence of a hazard causing harm and the degree of severity of the harm. Risk acceptance shall be based on the principle of "As Low as Reasonably Practicable" (ALARP) based on the guidelines set out in EN 50126.

(2) The frequency of occurrence of hazardous event is categorized into different rankings:

Category	Description
Frequent	Likely to occur frequently. The hazard will be continually experienced.
Probable	Will occur several times. The hazard can be expected to occur often.

Occasional	Likely to occur several times. The hazard can be expected to occur several times.
Remote	Like to occur sometime in the system life cycle. The hazard can be reasonably expected to occur.
Improbable	Unlikely to occur but possible. It can be assumed that the hazard may exceptionally occur.
Incredible	Extremely unlikely to occur. It can be assumed that the hazard may not occur.

(3) The hazard severity is categorized into different hazard consequence levels:

Hazard Category	Consequence	Description
4	Catastrophic	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.
3	Critical	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.
2	Marginal	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage. Acceptable with adequate control and agreement of the Employer.
1	Negligible	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

(4) Risk classification of hazards:

Frequency		Consequence			
		Catastrophic (Category 4)	Critical (Category3)	Marginal (Category2)	Negligible (Category1)
Frequency	Frequent	I	I	I	II
	Probable	I	I	II	III
	Occasional	I	II	III	III
	Remote	II	III	III	IV
	Improbable	III	III	IV	IV
	Incredible	IV	IV	IV	IV

(5) The Risk Classes are defined as follows:

Risk Class		Interpretation
Class I	Intolerable	Intolerable risk. Shall be eliminated
Class II	Undesirable	Undesirable risk, and tolerable only if risk reduction is impracticable of if the costs are grossly disproportionate to the improvement gained. Shall only be accepted when risk reduction is impracticable and with the agreement of the Railway Authority or the Safety Regulatory Authority, as appropriate
Class III	Tolerable	Tolerable risk if the cost of risk reduction would exceed the improvement gained. Acceptable with adequate control and with the agreement of the Railway Authority.
Class IV	Negligible	Negligible Risk. Acceptable with/without the agreement of the Railway Authority

(6) Risk acceptance shall be based on the principles of "As Low as Reasonably Practicable" (ALARP) and as follows:

a. Category 4 hazards: Shall be eliminated.

b. Category 3 only be accepted when the risk reduction is impractical and with the agreement of the Employer.

c. Category 2 hazards shall only be permitted if a desired benefit is demonstrated as generally acceptable within accepted levels for the international railway industry and in agreement with the Employer.

d. Category 1 hazards shall only be permitted if assured that the risk will remain at that level and any residual risk shall be mitigated by Operating Rules and Procedures.

12.9.5 Hazard Analysis

(1) Hazard analysis shall be carried out to:

a. Identify and record all reasonably foreseeable hazards associated with all phases of the Works;

b. Assess the risk that each hazard represents to this operation; and

c. Re-assess the risk after application of the proposed mitigation.

(2) Where it is not reasonably practical (based on good practice or application of the ALARP principle) to eliminate hazards at the design stage, risk assessments shall be carried out to ensure that the risks associated with residual hazards are in order of precedence:

a. Minimized through mitigation measures at the design stage;

b. Mitigated through special construction, installation and testing and commissioning processes; and

c. Mitigated through operations and maintenance procedures.

(3) Additional mitigation measures shall be proposed as required until such time as the residual risk is assessed to be 'as low as reasonably practicable'.

(4) The results of the hazard analysis shall be recorded in a Hazard Log in a form that can be used to track progress in the implementation of mitigating actions and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard.

12.9.6 Primary hazards for Preliminary Hazard Analysis (PHA)

(1) The PHA shall take into account, but not be limited to, the following primary hazards:

a. fire including:

i. smoke asphyxiation;

ii. hot works; and

iii. explosion;

b. impact including:

i. collision;

ii. derailment;

iii. falling objects;

iv. flying objects;

v. sharp objects;

vi. slipping, tripping and falling;

c. electrocution;

d. other hazards including:

i. environmental;

ii. flooding;

iii. noxious fumes;

iv. suffocation;

v. entrapment; and

vi. burns.

(2) The PHA shall take into account the various types of operating mode (i.e. normal, degraded and emergency) and the operating scenarios during which all types of hazards might exist including, but not limited to:

a. freight service;

b. evacuation; and

c. maintenance.

(3) The PHA shall take into account the how each type of hazard might arise including, but not limited to:

a. inappropriate design or specification;

b. equipment failure;

c. installation error;

d. improper action (accidental or deliberate);

e. inaction (unintentional or intentional); and

f. external influence.

(4) The PHA will be followed with the following detailed hazard analysis:-

a. Sub System Hazard Analysis (SSHA)

b. Interface Hazard Analysis (IHA)

c. Operating and Support Hazard Analysis (O&SHA)

(5) The hazard analysis will be supported by following assessment methods:

a. Failure Mode, Effects and Criticality Analysis (FMECA)

b. Fault Tree Analysis (FTA) of top level hazard scenarios.

12.9.7 Design Safety Studies and Report

(1) The hazard analysis process shall identify the need for Design Safety Studies and the Hazard Log shall record the results of each of these Design Safety Studies.

(2) Design Safety Studies shall be undertaken for system and subsystem elements that are considered to be safety critical and that require hazard analysis to a greater level of detail than that applied at an overall system wide level.

(3) Design Safety Studies shall specifically refer to hazards arising from:

a. normal operations including maintenance;

b. degraded modes of operation;

c. emergency situations; and

d. the effectiveness of mitigation proposed for natural catastrophes.

(4) The Design Safety Studies shall take account of:

a. methods of operation;

b. RAM considerations;

c. anticipated likely maintenance regimes and their sustainability in Commercial Operation;

d. anticipated competence levels of personnel in Commercial Operation;

e. software security (disabling of unauthorized access to operating systems, protection against intrusive attacks, loss of password integrity, etc.); and

f. other human factors including but not limited to those identified in ergonomic studies.

(5) Design/Systems Safety Studies and the Report shall demonstrate, as a minimum, the following requirements:-

a. That the overall risk criteria for the Works have been addressed satisfactorily at the Detailed Design stage and that the Detailed Design proposals are mutually compatible with such risk criteria.

b. That all Safety Critical systems have been identified at the Detailed Design stage and the apportionment of risk factors between the major systems and sub-systems support the overall safety criteria approved in the "System Safety Plan".

c. That the results of the Design Safety Studies have been incorporated into the design, and shall be carried forward into the Final Design, manufacturing and installation processes.

d. That where management by operating and/or maintenance procedure or other management control measures have been identified during the "Design Safety Studies", auditable methods by which such measures shall be introduced into operating/maintenance provisions have been established.

e. That robust processes have been implemented to validate the Safety Critical aspects of software design.

f. That processes for assessing the potential safety impact of design changes exist.

(6) A Design Safety Studies and Report shall be submitted at the completion of the design stage to confirm that all safety related aspects of design have been properly addressed and comprehensively verified.

12.10 SOFTWARE QUALITY ASSURANCE PROGRAM (SQAP)

12.10.1 Each software suppliers for Contractors and System Suppliers shall assure software dependability by establishing and implementing a Software Quality Assurance Program (SQAP). The SQAP will:

(1) Identify, monitor and control all technical and managerial activities necessary to ensure that the software achieves the required quality.

(2) Ensure that an audit trail is established which enables verification and validation that the SQAP activities were effectively completed.

12.10.2 Each software supplier shall provide evidence that the SQAP activities were carried out, by submitting the documents in given in the Table below.

Documentation	EN Standard
Software Project Management Plan	EN 50128 section 5
Software Quality Assurance Plan	EN 50128 section 6.5
Software Configuration Management Plan	EN 50128 section 6.5, 6.6
Software Verification and Validation Plan	EN 50128 section 6.2, 6.3
Software Requirements Specification	EN 50128 section 7.2
Software Design Description	EN 50128 section 7.3, 7.4
Software Verification and Validation Report	EN 50128 section 6.2, 6.3
Traceability	EN 50128 section 5.3.2.7,D.58

Table 1: Software Quality Assurance Plan Requirements

12.11 RAM DEMONSTRATION

12.11.1 Reliability Demonstration

(1) Contractor and System Supplier shall perform a Reliability Demonstration to verify that the system meets the required reliability performance requirements when:

a. Scheduled maintenance is performed in accordance with approved Maintenance Plan and Maintenance Manuals, and

b. Systems are operated within the environmental limits described in the Design documents.

(2) The demonstration of the system shall continue for a period of 24 months. If at the end of the 24 month test period the equipment has not met the reliability requirements, the System Supplier will implement design changes or modifications, as needed, to meet the reliability requirements. The test duration will be extended to ensure that the changes made result in achieving the requirements.

(3) Contractor shall submit a RAM Demonstration Test Plan before the Final Design Review. The plan will address the following to illustrate compliance with the reliability requirements:

a. Plan schedule and period

b. Identification of necessary facility, resources, support equipment, and staff for the demonstration

c. RDT procedures and forms for recording and submitting data

d. Success failure criteria for measuring reliability values for individual equipment items and subsystems

e. Failure analysis of reported failures to identify the cause and need for corrective action

f. Establish a Failure Review Board (FRB) to meet with Employer, as required, to determine the need and depth of failure analyses

g. Change control procedures for implementing design changes

h. Format and location of test records, test logs, and data records

i. Final conclusion and report for the demonstration.

(4) The employer will approve the RAM Demonstration Plan and procedures before the trial commences.

(5) The RAM Demonstration Procedures shall include all information necessary to ensure the successful, accurate and safe performance of the demonstration testing. The RAM Demonstration Procedures will include, as required:

a. Safety Precautions

b. Identification of the reliability performance parameters that are verified by the test

c. Scope of test

d. Test equipment required, if any.

e. Personnel required

f. Any special conditions required, including condition of the equipment under test

g. Reference drawings or documents

h. Clear pass/fail criteria

i. Data sheets to record test results

j. Raw data correlation procedures

(6) RAM Demonstration Procedures shall address the following:

a. Each equipment failure reported during the RAM Demonstration will be classified as relevant or non- relevant failures by the Failure Review Board (FRB). The assessment will include all failures, whether occurring in or out of revenue service.

b. A proposed procedure for corrective action shall be developed and included. The procedure will include proposed changes and appropriate supporting data. The procedure will identify a specific method for verifying the effectiveness of change(s).

c. Preventive maintenance procedures specified for the equipment during the RAM Demonstration phase will be performed by the maintainer in accordance with applicable Contract Terms and Conditions.

d. System suppliers shall maintain records which contain all the information necessary to calculate reliability performance for the system and major subsystems, and to verify satisfactory reliability requirements. System suppliers shall provide failure and reliability performance records to employer in hard copy and in an approved electronic format.

(7) A chargeable failure in the RAM Demonstration is defined as any relevant failure that requires repair or replacement of any subsystem or vehicle component. Chargeable failures also include intermittent failures, unverified failures, and software failures.

(8) Non chargeable failures in the RAM Demonstration are:

a. Consumable items, except for those which are not achieving their specified life

b. A failure occurrence in equipment of another subsystem, due to the primary failure

c. A failure of the operator/maintainer to perform recommended preventive maintenance actions

d. Vandalism or physical mistreatment at a human interface

e. Failures due to an accident.

(9) Contractor shall provide Weekly Failure Reports during the RAM Demonstration phase. The Contractor will submit the format and structure of the report to employer for review and approval at least three months before system commissioning begins.

(10) Contractor shall submit Monthly Demonstration Test Reports to employer documenting the current and cumulative failure totals for the system equipment, comparing the totals to the reliability requirements.

(11) All reports shall clearly identify the system being tested, the date(s) of test, any conditions that may have affected results, and pass/fail status. The test record sheet shall be signed by the personnel performing and witnessing the test. All measured data shall be recorded in numeric form on the reports (not just checked off as acceptable). For the RDT, this means that the applicable support data for the RDT must be included with the RDT Report.

12.11.2 Availability Demonstration

(1) The Contractor shall demonstrate the specified Availability during Service Trials and during the DLP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

(2) In the event that the availability target is not achieved, the determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

(3) In the event that the availability target is not achieved, the Contractor shall, at his own expense, take whatever action is deemed necessary to meet the availability requirement.

(4) The contractor will submit the Availability Demonstration Test Report on completion of the demonstration testing.

12.11.3 Maintainability Demonstration

(1) Contractor and equipment Supplier shall conduct a Maintainability Demonstration (MD) to establish the accuracy of task time estimates for the preventive and corrective maintenance tasks described in the applicable Maintenance Plan, Maintenance Procedures, and/or Maintenance Manuals. Contractor and equipment Supplier will perform the MD concurrent with the Engineer training program. Contractor and equipment Supplier will demonstrate selected servicing, preventive maintenance, troubleshooting, change out of components, corrective maintenance, and use of special tools where special emphasis, instruction, or proficiency is needed. The Engineer will notify equipment Suppliers which preventive and corrective maintenance tasks have been selected for the MD.

(2) Maintainability Demonstration Test Plan shall be provided before the Final Design Review.

(3) In the event that any maintainability target is not achieved, the Contractor shall at his own expense take whatever action is deemed necessary to meet the maintainability targets.

(4) The contractor shall submit a Maintainability Demonstration Test Report on completion of the demonstration testing.

12.12 FAILURE REPORTING AND CORRECTIVE ACTION SYSTEM (FRACAS)

12.12.1 Purpose of FRACAS

Contractor shall provide a Failure Reporting and Corrective Action System (FRACAS) that supports requirements of the RAM Demonstration and Warranty Program. The contractor shall submit the FRACAS for employer's approval before the Final Design Review. Contractor will use a Failure Reporting, Analysis and Corrective Action System (FRACAS) to track and report on system failures. The FRACAS will consist of a set of data management tools for capturing and reporting on equipment incident data, and a set of procedures which use the data management tools. The FRACAS procedures:

(1) Implement key project functions of reliability demonstration and warranty administration

(2) Assess compliance of delivered equipment with requirements

(3) Provide field and operating information to equipment and project design and analysis tasks

(4) Assess the effectiveness of modifications to equipment in the field.

12.12.2 Where system failures indicate the possibility of a non-compliant design, the FRACAS process will consist of the following activities:

(1) Communication of failure information from the operating authority to System Suppliers

(2) Assessment of the failure conditions, impacts, and possible causes by the System Supplier Quality Assurance and Engineering departments, and by equipment suppliers

(3) Where appropriate, failure analysis by the equipment supplier

(4) Corrective action by the equipment supplier

(5) Once corrective action has been completed through field or factory action, verification by the System Supplier that the implemented solution is adequate and acceptable.

12.12.3 FRACAS Guidelines.

(1) A comprehensive FRACAS closed loop diagram is depicted as under :

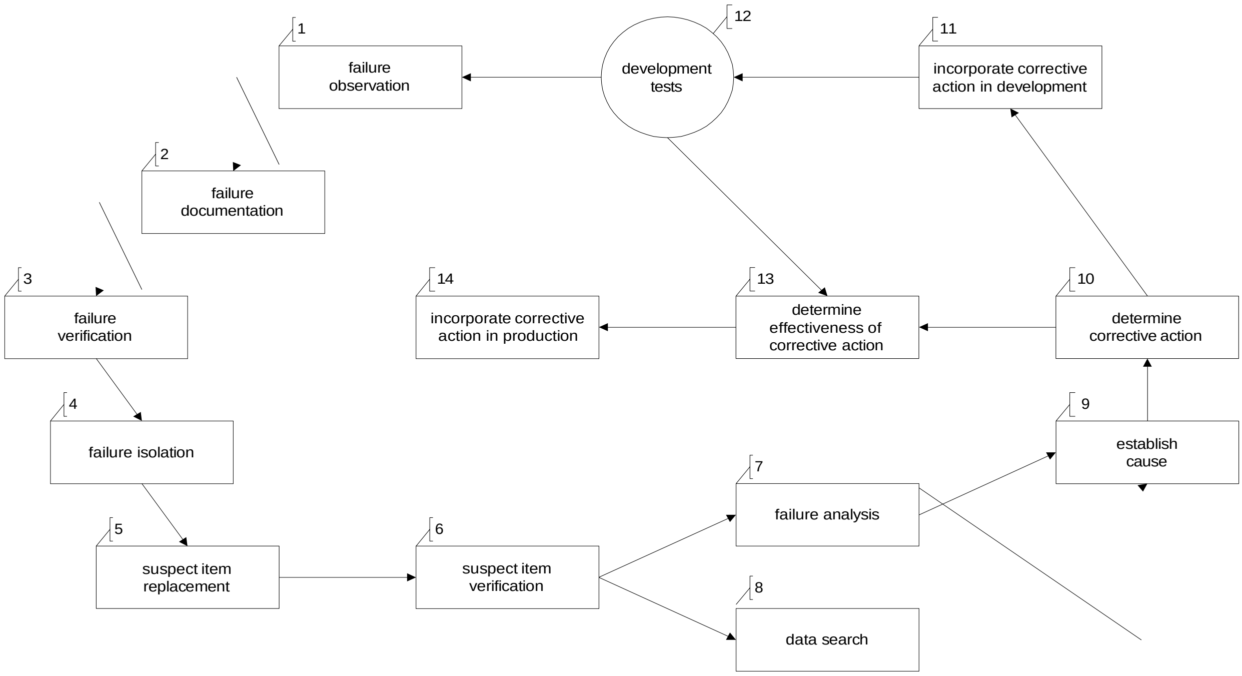


Figure 1: Generic closed-loop FRACAS

(2) Key steps in FRACAS are as follows:

a. Observation of failure

b. Complete documentation of failure including all significant conditions which existed at the time of the failure

c. Failure verification, i.e. confirmation of the validity of the initial failure observation

d. Failure isolation, localization to the lowest replaceable defective item within the product

e. Replacement of the suspect defective item

f. Confirmation that the suspect item is defective

g. Failure analysis of the defective item

h. Data search to uncover other similar failure occurrences and to determine the previous history of the defective item and similar related items

i. Establishment of the root cause of the failure

j. Determination, by the design team, of the necessary corrective action, especially any applicable redesign

k. Incorporation of the recommended corrective action into development equipment

l. Establishment of the effectiveness of the proposed corrective action

m. Incorporation of effective corrective action into the equipment

n. The failure documentation should be augmented with the verification of failure (step c above), and verification that the suspect part did indeed fail (step f).

12.13 FAILURE REPORTING FORMATS

12.13.1 Failure Report Forms: All failures shall be recorded on a failure report form which shall contain as a minimum the following information:

(1) Identification of the equipment, including nomenclature, serial number, manufacturer's part number and location;

(2) Location of failure;

(3) Individual who observed failure;

(4) Operating time of each system including each shut-down and its cause;

(5) Date and time of each incident;

(6) Failure symptom/indication, mode, cause and effect;

(7) Classification of the incident (relevant independent failure or dependent failure);

(8) Corrective maintenance or operational procedures required to restore the System to operation;

(9) Time to restore System to operation and active repair time; and

(10) Circumstances of interest such as Environmental conditions and supply voltages.

12.14 FAILURE DATABASE

12.14.1 The key to a successful FRACAS is its database. This is particularly important in establishing the significance of a failure. For example, the failure of a capacitor in a reliability growth test becomes more significant if the database shows similar failures during incoming inspection of the part and in any environmental tests performed. For this reason all available sources of data should feed the FRACAS.

12.14.2 The Contractor shall maintain the failure database throughout the execution of the Works. The FRACAS system along with the database shall be handed over to the Employer at the expiry of the Defects Notification Period.

12.15 FAILURE REVIEW BOARD

12.15.1 Failure review board (FRB) shall be established consisting of the Employer's Engineer and the Contractor. The FRB shall review failures and assign responsibility.

12.16 ON-SITE TESTING AND INTEGRATED SYSTEM TESTING

12.16.1 General Requirements

The On-site Testing and Integrated System Testing shall demonstrate as a minimum the following requirements:

(1) That the safety management organization to control the on-site Testing and Integrated System Testing is in place.

(2) The testing procedures shall ensure that all the critical failure modes as identified during the FMECA / FMEA activity are addressed through proper test cases inclusion. A traceability matrix shall be developed such that these critical failure modes are traced back to the corresponding test cases. All failure modes shall be considered as critical failure modes unless the Contractor demonstrates by a sensitive analysis or other means that the impact of a failure mode on reliability and maintainability will be insignificant.

(3) That the scope of activities to be carried out during the on-site Testing and Integrated System Testing period covers all Safety Critical functions and Safety requirements including those in the Hazard Log.

(4) That the segregation of on-site Testing and Integrated System Testing activities from residual construction and installation activities shall be implemented.

(5) That the procedures required to conduct on-site Testing and Integrated System Testing activities safely, including where necessary, the protection measures for any part of the Railway which may be in operation shall be implemented.

(6) That the processes which are to be implemented to validate the Safety Critical aspects of software installation and testing shall be implemented.

(7) That the processes required to assess the safety implications of the results of tests and inspections carried out during the periods of on-site Testing and Integrated System Testing activities shall be implemented.

(8) That the processes required controlling and validating the safety implications of modifications carried out during the period of on-site Testing and Integrated System Testing activities shall be implemented.

(9) That the arrangements which are to be utilized to record, report and investigate accidents and incidents together with the systems necessary to formulate and implement measures to prevent reoccurrence shall be implemented.

(10) That effective controls shall be implemented in respect of the activities of all other contractors, relevant authorities and third parties.

12.17 ENGINEERING SAFETY VALIDATION PLAN

12.17.1 Testing shall validate that all safety related functions have been implemented in accordance with the Detailed Design and the safety requirements identified in the Design Safety Report.

12.17.2 A Program of all safety validations to be carried out shall be submitted and this Program shall be updated with actual dates of validation during the on-site testing and integrated system testing phase.

12.17.3 Validation of the correct implementation of all safety design criteria shall be demonstrated by submitting details including:

(1) a cross reference to the Program of safety validations;

(2) the purpose of each validation;

(3) the method of each validation;

(4) the qualifications of staff performing the validation;

(5) the names of witnesses to the validation;

(6) the acceptance criteria for each validation;

(7) the results of each validation;

(8) analysis of validation results to show that they confirm requirements have been met; and

(9) the recommended procedure for the correction of deficiencies observed during the validation process and the steps required to repeat the validation.

12.18 OPERATIONAL SAFETY CASE

12.18.1 General Requirements

In order to demonstrate that the system shall be managed safely, the Contractor shall produce and maintain an Operational Safety Case, in accordance with the System Assurance requirements detailed in the Contract documents.

12.18.2 The Operational Safety Case shall typically consist of but not be limited to the following:

(1) Executive Summary;

(2) Introduction;

(3) Definition of System;

(4) Quality Management Report;

(5) Safety Management Report;

a. Introduction;

b. Roles and Responsibilities;

c. Safety Lifecycle;

d. Safety Requirements;

e. Safety Standards;

f. Safety Audit and Assessment;

g. Supplier Management;

h. Safety Controls;

i. Configuration Management; and

j. Project Safety Training.

(6) Technical Safety Report

a. Introduction;

b. Assurance of correct functional operation;

c. Effects of faults;

d. Operation with External Influences;

e. Safety-related application conditions;

f. Safety Qualification tests; and

g. Other Outstanding Safety Issues.

(7) Conclusion

12.18.3 As part of the Operational Safety Case development process, the Contractor shall ensure that plans and procedures as typically listed below will be in accordance with the Operational Safety Case requirements:

(1) System Management Plan;

(2) System Safety Plan;

(3) System Operating Safety Procedures;

(4) System Assurance Plan;

(5) Emergency Preparedness and Fault Recovery Plan;

(6) Rules and Procedures;

(7) Relative Indian Railways Rules and Procedures; and

(8) Health and Safety Regulations.

12.19 PROOF OF SAFETY

12.19.1 General Requirements

The "Proof of Safety" shall demonstrate that the Works are fit for the purpose of commencing Revenue Service. The "Proof of Safety" shall make traceable reference to system documentation that shall demonstrate as a minimum the following requirements have been met:

(1) That the Works have been manufactured, installed and tested up to an including Integrated System Testing in a manner to ensure that the Railway can be operated

and maintained within the parameters of risk as approved in the "Design/Systems Safety Report" and that there are no outstanding safety issues.

(2) That the recommended safety performance criteria and safety thresholds for the safe operation and maintenance of the Works have been met.

(3) That the standards and specifications upon which the safe operation and maintenance of the Works are based have been met.

(4) That the safe systems of work, rules and procedures required to operate and maintain the Works within the defined parameters of risk as approved in the "Design/Systems Safety Report" have been verified.

12.20 SYSTEM ASSURANCE DURING TRIAL RUNNING

12.20.1 Activities

The period of Trial Running shall include as a minimum the following activities:-

(1) Demonstration of system performance and adherence to timetables by running a simulated revenue service at progressively increasing levels of service.

(2) Evaluation of the effectiveness of normal operating procedures including those that deals with minor disruptions and staff unavailability.

(3) Evaluation of the effectiveness of system fault reporting, fall back systems, operating procedures and maintenance responses in the event of a number of system failures and degraded operating scenarios by simulating such scenarios during simulated revenue service.

(4) Evaluation of the effectiveness of operating procedures and other incident management responses in the event of a serious incident including but not limited to fire by simulating such scenarios during simulated revenue service.

12.21 SYSTEM ASSURANCE DURING REVENUE SERVICE RUNNING

12.21.1 General Requirements

The Contractor shall continue to implement system assurance activities during and after the transition to revenue service including, but not limited to, the following requirements.

(1) Revenue Service shall not commence until the "Proof of Safety" has received the approval of the Employer.

(2) During the Defects Correction Period, day to day monitoring of the Railway RAM performance shall be carried out and the findings shall be used to enable systematic means of data analysis and recording of the RAM performance.

(3) In the event that a defect/failure shall arise, the Contractor shall provide full technical support in failure investigation and rectification.

(4) The Contractor shall employ suitable mechanisms and develop a suitable organization structure in conjunction with the Employer to support ongoing RAM activities.

(5) The Contractor shall provide support to the Operator to ensure that the documentation and processes defined in the Ongoing Management of Safety document have been fully assimilated into the Operator's Safety Management System and organization.

12.22 SYSTEM ASSURANCE DURING DEFECT NOTIFICATION PERIOD (DNP)

12.22.1 Defect Notification

The Defect Liability /Notification Period shall be of 36 Months from the date of Taking Over of works and shall be monitored for RAMS compliance. The Failures and Performance shall be monitored on monthly basis and the result should meet the acceptable criterions. If the results of 6 months average do not meet RAM specifications than the DNP period shall be extended with full DNP obligations of the Contractors. The same may be extended with /without penalty for further period similarly.

12.22.2 DNP - Major Activities

During the Defect Notification Period (DNP) of the project, the following activities shall be carried out by the contractor:

(1) Keep full records of any failures and the actions taken to restore the equipment to full service and input the record data in the FRACAS for the FRB panel to evaluate.

(2) During this period the Contractor shall replace/ remedy from his resources the defects occurring under normal usage of Works by the Employer except for normal wear and tear under such usage.

(3) During Defect Notification Period, Contractor shall maintain the required spares and Tools and Plants at identified place as agreed with the Employer's Engineer. The Contractor shall not utilize any spares intended to be delivered to the Employer.

(4) The Contractor shall maintain a qualified team of the required technicians and Engineers to meet DNP obligations. The Contractors shall submit a Manpower Plan showing the Contractor's organization available during Defect Liability Period.

(5) The Contractor shall attend the periodic FRB Meeting with the Employer/Engineer to discuss the defects arising during the Defect Notification Period. The dates and agenda of the meeting shall be as per the consent by the Engineer.

(6) If the Contractor fails to remedy any defect or damage within a reasonable time, a date may be fixed by (or on behalf of) the Employer, on or by which date the defect or damage is to be remedied. The Contractor shall be given reasonable notice of this date.

12.23 SYSTEM ASSURANCE SUBMISSIONS

12.23.1 Deliverable Documents

The Contractor shall implement and submit system assurance supporting documents in accordance with the approved System Assurance Plan. The Contractor shall implement and submit system assurance supporting documents in accordance with the approved System assurance plan.

S No	Document Description	Plan Development Stage					Remarks
		Design Stage		Manufacture/ Construction h/Installation	Testing/ Trial Run Stage	Warranty Stage	
		PRELIM	FINAL				
1	System Assurance Plan (included System RAM Plan and System Safety Plan)	P					Shall be submitted within 90 days from the commencement date.
2	System RAM Plan		U	U	U		
3	System Safety Plan		U	U	U		
4	Safety Policy	P					Shall be submitted within 90 days from the commencement date.
5	Hazard Analysis and Hazard Log	P	U	U	U	U	First report shall be submitted within 14 days after the preliminary design completion. The report to include Safety Requirements Specifications and Safety Critical Item List (SCIL).

S No	Document Description	Plan Development Stage					Remarks
		Design Stage		Manufacture/ Construction h/Installation	Testing/ Trial Run Stage	Warranty Stage	
		PRELIM	FINAL				
6	Design/ Safety Studies and Report		P	U	U		First report shall be submitted within 14 days after the final design completion. The report shall at least include the Safety Requirement Specification, Hazard Log, Deterministic Safety Assessment, Quantitative Risk Assessment, Safety Integrity Level Analysis, Failure Mode, Effect and Criticality Analysis, Reliability Block

							Diagram
7	RAM Analysis and Prediction Report		**P**	**U**	**U**	**U**	First report shall be submitted within 14 days after the final design completion.
8	FMECA		**P**	**U**	**U**	**U**	First report shall be submitted within 14 days after the final design completion.
9	RAM Test / Demonstration Plan		**P**	**U**	**U**	**U**	First report shall be submitted within 14 days after the final design completion. The demonstration plan shall include the proposed FRACAS system.

S No	Document Description	Plan Development Stage					Remarks
		Design Stage		Manufacture/ Construction h/Installation	Testing/ Trial Run Stage	Warranty Stage	
		PRELIM	FINAL				
10	RAM Test / Demonstration Report				**P**	**P**	- Reports shall be submitted separately within 14 days after each completion of demonstration tests in terms of maintainability demonstration test, and availability / reliability demonstration test. - Monthly RAM Demonstration Records and Reports shall be submitted on 7th day for preceding month ended during Operations Period.
11	Engineering Safety Validation Plan		**P**	**U**	**U**		First report shall be submitted within 7 days after the final design completion.
12	Engineering Safety Validation Report				**P**		Shall be submitted within 7 days after completion of safety validation test.
13	Operational Safety Case	**P**			**P**		Second report shall be submitted within 7 days after the completion of safety validation test.

P - Document Produce
U - Document Update

(End of Chapter 12)

CHAPTER 13 - TRAINING AND SERVICE LIFE SUPPORT

13.1 GENERAL

13.1.1 Training Requirements

(1) The Contractor shall provide comprehensive training to the Employer's Personnel in respect of design, system engineering, construction/ installation, assembly, configuration, operations, fault diagnosis and maintenance of the systems/sub-systems, provided under the Contract.

(2) The Contractor shall arrange training at units/places/ works where the greatest benefit shall accrue to the trainee engineers w.r.t. design, system engineering, and assembly, installation, configuration, testing & fault diagnosis. The Contractor shall arrange Training at manufacturer's premises as well at site, as per the approved Training Plan and also as specified in respective Particular Specification.

(3) The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

(4) The Contractor shall also arrange training at site for the trainee operational staff and maintenance staff. The Contractor shall set up training class rooms/use conference hall(s) near to site, where he shall provide competent training instructors, training manuals, all necessary aids/ demonstrable examples and materials as required for all the training courses. The training courses at site shall cover working principles, installation, operation, fault diagnosis & maintenance of all major equipment and works engineered by the Contractor. All the training courses at site shall be conducted during installation period and completed before the commencement of testing and commissioning. Such training courses shall be held at a venue to be arranged by the contractor at his cost. The Employer, may, however, permit the use of the rooms if available with him free of cost.

(5) The training instructors, for training courses, shall be qualified, competent, with sufficient years of practical experience and possess good communication skills in the relevant fields. The training shall be in the English / Hindi languages as required. All training material for these courses shall be in English / Hindi as required.

(6) Should, in the opinion of the Engineer and due to good reasons, any of the Contractor's training instructors not considered competent or not to have a suitable attitude or aptitude for carrying out the training courses for whatever reason, the Contractor shall remove the said person and replace him as soon as possible with an acceptable substitute.

(7) The Contractor shall provide full-time management, co-ordination and supervision of the entire training Program to ensure the continuity of classes and proper distribution of training materials and be responsible for interfacing with the instructors.

(8) The Contractor shall bear all the Training costs except for allowances, hotel and travel expenses of the Employer's trainees.

13.1.2 Training Plan

(1) The Contractor shall prepare and submit a Training Plan to the Engineer for review.

(2) The Training Plan shall include as above, but not be limited to:

a. the program of the training courses at OEM's Works and at site;

b. overview and description of objectives of each training course;

c. the location where the training courses to be conducted;

d. submission schedule of the training materials;

e. set ups for practical exercises;

f. the Contractor's training organisation chart, including the role and responsibilities of individual key persons;

g. the qualifications and experience of the training instructors;

h. duration of training for each module,

(3) The Training shall be imparted both at the manufacturer's premises as well as at the site. The duration of the training at manufacturer's premises and/or at the work site is detailed in the PS, Section VII-2 for Electrical (PSI, OHE, ROCS and SCADA).

13.1.3 Training Courses

(1) The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, firmware and software. Each Course shall be specific and shall consist of classroom, hands-on and/or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan. The Contractor shall develop detailed training modules based on information in the Operating and Maintenance manuals.

(2) The technical training courses to the Employer's staff shall be programmed in phases with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the equipment which is the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Equipment with maximum effort being directed at instruction in the maintenance of the installations.

(3) Training at site shall include operation courses and maintenance courses. The class will be of maximum of 30 trainees. The Contractor in consultation with Engineer and Employer shall determine the number of classes for each type of training course, within the provisions available in respective Particular Specification, to ensure the objectives of the course can be met.

(4) **Training Course for Operating Staff**

a. The training courses for operation staff at site shall be developed to provide all necessary knowledge and skills for operations staff of the Employer for operating the system under normal and emergency situations and recovery from minor or simple faults. In particular, the training course shall include the following as minimum:

(i) overview of the system/sub-system;

(ii) brief description of the operation principles of the system/sub-systems;

(iii) operational features and functions;

(iv) familiarisation and use of all man-machine interfaces involved;

(v) reading and interpretation of system status and alarm messages or indications;

(vi) normal operating procedures;

(vii) operating procedures under emergency situations;

(viii) procedures for recovery from minor or simple faults; and

(ix) use of Operation Manuals and documentation.

(x) A comprehensive list of Dos and Don'ts shall be prepared and explained to the operating personnel and also shall be prominently displayed at site.

b. Particular exercises shall be included in the training course for operation staff at site for each trainee to operate and manage the system under normal and emergency operating conditions and simple faults recovery.

(5) **Training Course for Maintenance Staff**

The training courses for maintenance staff at site shall, as a minimum, impart the following techniques to maintenance staff of Employer of the appropriate grades:

a. All planned maintenance and overhaul of the systems supplied & installed;

b. Fault finding and rectification techniques for the systems/subsystems including equipment supplied, installed or modified under the Contract. These shall be developed from the Contractor's previous experience with similar equipment and also from the fault tree analysis and other analysis carried out as part of the reliability engineering studies undertaken by the Contractor;

c. Normal and degraded modes of operation of the HORC systems/subsystems including equipment supplied, installed or modified under the Contract;

d. All rules, regulations, practices and procedures necessary for the safe & efficient operation of the systems supplied, installed or modified under the Contract; and

e. All contingency plans necessary to recover speedily and safely from any mishaps or emergencies that may arise with the HORC systems supplied and installed or modified.

(6) The Contractor shall provide all training material including presentations, mock-ups, models, tables, chairs, white boards, and so on.

(7) The Training during operation courses and maintenance courses shall enable trainee operation and maintenance staff to achieve Competency Certificate from the competent authority.

(8) The training courses for system engineers at manufacturing facilities shall be developed to provide all necessary knowledge and skills to perform system engineering management including system parameter configuration,

enhancement, expansion and provision of new circuits.

(9) The Contractor shall determine the content of the system engineering courses, however the courses shall include the following as minimum:

a. overview of the system/subsystem;

b. background theory;

c. system features and functions;

d. system configuration and operation principles;

e. description of system components and equipment down to card or module level;

f. test and commissioning procedures;

g. use of test equipment and special tools;

h. reading and interpretation of alarm indications, messages and print-outs;

i. preventive maintenance procedures;

j. fault diagnosis, troubleshooting and corrective maintenance procedures;

k. equipment settings and parameters configuration;

l. use of equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;

m. methods and procedures to provide new circuits, system expansion and enhancement;

n. data, software backup and loading; and

o. use of software such as peripheral control and configuration, utility, database structure, generation and modification.

p. Periodical Maintenance schedules and impacts;

q. Familiarisation and use of all man-machine interfaces involved;

r. Normal operating procedures;

s. Operating procedures under emergency situations; and

t. Procedures for recovery from faults

(10) During the Defects Notification Period, when the Contractor is responsible for faultfinding and repair, he shall provide practical hands on training to Employer maintenance staff to facilitate successful handing over of the works.

13.1.4 Training Material and Equipment

(1) With the prior approval of the Engineer, the Contractor may use the Works being erected, tested or commissioned for the training of Employer Personnel.

(2) Training course notes shall be entirely compatible and where appropriate, cross-referenced to the manuals supplied by the Contractor as part of the Operation & Maintenance documents.

(3) The Contractor shall provide such written or printed matter, functional equipment, samples, models, cutaway equipment, slides, films and other instructional material, as may be necessary for training. Such equipment and material shall remain the property of the Employer and shall be sufficient both for the persons trained by the

Contractor and for those to be subsequently trained by Employer Training Instructors.

(4) The Contractor shall provide an instructor's guide for each training course. The guide shall include the course agenda, objectives, list of resources and facilities required, detailed lesson plans, presentation notes, discussion guides, training aids and job aids, test papers, criteria and methodology for testing and assessment, and all other things that will enable Employer's Training Instructors to carry out repeat or refresher courses in the future.

(5) At the commencement of the training course, the Contractor shall, distribute two sets of Trainer's guides in hard copy and one set of Training manual in hard copy for each trainee. Contractor shall supply three sets of Trainer's guides and three sets of Training manual in hard copy as well as in editable softcopy to the Engineer.

(6) All training course notes and instructor's guides shall be submitted to the Engineer for review three (03) months prior to the commencement of the first training session of the course.

(7) All training course notes/instructor's guides shall be in easy reproducible form.

(8) All training course notes/instructor's guides shall be in format as decided by the Engineer.

13.1.5 Training Course Evaluation / Test and Assessment/Training Records

(1) The Contractor shall develop a system for assessment and certification of trainees to assess and verify their proficiency in the subjects being trained. The assessment and certification procedures shall be submitted to the Engineer for approval. At the end of the training period, the Contractor shall issue 'training certificate' to the trainees participated. Training sessions, tests, and certification processes may be witnessed by the Engineer and the Employer's Personnel.

(2) The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Engineer for review four weeks before the commencement of the training course.

(3) The contractor shall submit the course evaluation criteria to the Engineer for approval.

(4) The Progress of Training shall be evaluated by the Engineer at regular intervals for adequacy and arrangement of training. Items that require further information or tasks that require additional training or practice will be discussed between Engineer and the contractor at the evaluation meetings. Such items or tasks must be appended to the training Program as soon as possible.

(5) The Contractor in consultation with the Engineer, shall develop a system of Feedback after each Training course. The Feedback forms shall measure the Trainee's level of satisfaction with the course content. The Feedback form shall be submitted to the Engineer for review four weeks before the commencement of the Training course.

(6) After two weeks, the Contractor shall submit a Training report to the Engineer for

review. The Training report shall include a summary of the training course conducted, training course title, date of training, the results of trainees' assessment and the Feedback report including attendees, trainer and training material.

13.2 SERVICE LIFE SUPPORT

13.2.1 The Contractor should ensure availability of full support to the Employer for operation, maintenance, customization and up gradation of system/sub-system supplied and installed by him as part of the Contract.

13.2.2 The Contractor shall undertake to provide, if required during the life of the equipment provided under Contract, technical assistance in the form of additional drawings, maintenance practices and technical advice (including training).

13.2.3 For all imported systems/subsystems, the Contractor must ensure:

a. Establishment of Servicing facility in India.

b. Establishment of Customization facility to add/modify/re-engineer hardware/software of the subsystem as required by the Employer during the lifetime of the equipment for adding facilities including up gradation etc.

c. Establishment in India to undertake Annual Maintenance Contract (AMC) during the service life of the equipment.

d. Supply of Spares for entire service life of the equipment.

e. Supply additional equipment required for replacement or expansion of the network in future.

f. Training of Employer's Personnel to reach qualified levels for operation and maintenance.

13.2.4 The Local Service Centre shall have test and repair facility with simulation test set-up, fault diagnostic system, test jigs, software for testing of cards/modules along with required test instruments and tools.

13.2.5 The Contractor/OEM of the system/subsystem shall be required to undertake comprehensive Annual Repair Contract (ARC) at the end of Defect Notification Period. The comprehensive ARC may include supply of cards/modules for repairs/replacement of the sub system/system.

13.2.6 The contractor shall ensure that the OEM should either provide support as above on his own or sign an MOU with suitable Indian companies or company having proven track record and are working in related areas for all imported systems/subsystems. The copy of the MOU shall be submitted to the Employer as a proof of continuous support.

13.2.7 The sub systems/systems of OEMs who are for complete Transfer of Technology (TOT) including system assembly, manufacturing, installation, maintenance and software modification/customization, training etc. shall be preferred for use by the Employer. In such case, the contractor shall submit the detailed plan for progressive manufacture of imported items by OEM in India.

13.2.8 Cost of any supply / service provided by the Contractor / OEM beyond DNP /extended guarantee period (wherever applicable), shall be borne by the Employer.

(End of Chapter 13)

CHAPTER 14 - OPERATION & MAINTENANCE & SPARES

14.1 GENERAL

14.1.1 Operation and Maintenance is an important element in the execution of a project. It is essential to have a well-designed Operation & Maintenance Support Plan and Maintenance Plan before the system is made Operational. These plans shall be submitted to Engineer for review, at least six months before start of Defect Notification Period.

14.1.2 It shall be ensured that the resource requirement in terms of men and material as identified in the Plans is available before the system is made Operational.

14.1.3 The Contractor shall repair and/or replace, in each case at no cost to the Employer, any part of the Works which is found to be defective by reason of faulty design, materials or workmanship or negligence or failure on the part of the Contractor to comply with any obligation expressed or implied under the Contract, during the DNP after the date of issue of the Taking Over Certificate of the Works. The Works shall also include equipment being provided under Contract Package SYS-1 which shall be upgraded/augmented/reconfigured, under this Contract if so required.

14.1.4 During the Defects Notification Period, as a result of an inspection made by or on behalf of the Employer at any time or times prior to its expiration, the Engineer shall have the right but not the obligation to instruct the Contractor in writing to execute all such work of repair, amendment, rectification and make good defects, imperfections or other faults in the Works and any part thereof, as the case may be.

14.2 OPERATION & MAINTENANCE PLAN

14.2.1 The Contractor shall prepare and submit Operation & Maintenance Plan for review by the Engineer. Operation and Maintenance Plan shall cover, but not limited to, the following items:

(1) Submission of Technical Manuals as per respective Particular Specification;

(2) Submission of Operation & Maintenance Manuals for each item/unit/equipment as per respective Particular Specification;

(3) Submission of procedures for preventive & corrective maintenance, overhaul / renewal and for handling break-downs.

(4) Requirement of Employer's Manpower for maintenance;

(5) Proposed Contractor's Manpower for Supervision of Maintenance during Defect Notification Period;

(6) Operation & Maintenance training requirements for Employer's Personnel ;

(7) Provision of Software Support during 'Defect Notification Period';

(8) Provision of Spares, Test Equipment, Tools, etc. as per respective Particular Specifications;

(9) Requirement of periodic operation of equipment and machines which would otherwise deteriorate because of non-operation for extended periods;

14.3 SUPPORT DURING DEFECT NOTIFICATION PERIOD (DNP)

14.3.1 Support and Call-out Services

(1) The Contractor shall provide the Support & Call-out-services for maintenance of the system. The maintenance will be done by the Employer with the support of the Contractor. The Support and Call-out services shall be available 24 hours per day and 7 days per week.

(2) The Contractor shall deploy adequate, committed and competent resources for providing desired level Support and Call-out-services. As a minimum, the expert of each sub-system shall be provided by the contractor at every major location and at PSI and OHE depots. All the resources shall be trained before deployment.

(3) The resource deployment shall be as per Operation and Maintenance Support Plan approved by the Engineer. The Contractor shall provide a list of staff together with the contact landline/mobile telephone numbers who can be contacted for Support and Call-out-services. Any change in the staff or his call-out number shall be notified to the Engineer at least two weeks before such change becomes effective.

(4) The Contractor's response Time for Support & Call-Out-Services shall not exceed one hour. The Response Time is defined as the time that elapses between the reporting of a fault and the Contractor's Call out personnel arriving at site where the faulty equipment is located.

(5) In case of any abnormal System behavior like intermittent faults, interference, frequent repeated faults, etc. occur or the performance is found to deviate from the specified tolerances, the Contractor shall conduct investigations and report the findings to the Engineer along with the recommendations and proceed after the recommendation has been reviewed without objection by the Engineer. The Contractor shall take every precaution to protect existing equipment from damage and make good any damage caused.

14.3.2 Workshop Repair

(1) The Contractor shall provide Workshop repair services for all defective and faulty items of the System and shall collect and repair defective parts that are removed from the System during corrective and predictive maintenance.

(2) The Contractor shall perform all necessary adjustments or alignments as required to the repaired parts. The repair of defective parts can only be considered as completed and returned to stock or back to the System if the parts are tested and verified fit for use in the System.

(3) The Contractor shall use only components of equal or better specification than the original components in his repair activities. The performance of the defective parts after repair shall not be degraded or deteriorated due to repairs.

(4) The maximum turnaround time for workshop repair shall be less than 28 calendar days. The turnaround time count shall start from the time the defective parts are removed from the System and shall continue till the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

14.4 EXTENSION OF DEFECT NOTIFICATION PERIOD

14.4.1 In case of failure of the Contractor to achieve the RAMS Targets specified in the Employer Requirement:

(1) The Defects Notification Period shall stand extended for a further period corresponding to period of failure;

(2) The Performance Guarantee shall stand extended for a period corresponding to the extension of the Defects Notification Period; and

(3) All work required to be carried out by the Contractor for the rectification of defects, shall be carried out at the Contractor's own expense.

14.5 OPERATION AND MAINTENANCE (O&M) MANUALS

14.5.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of systems such as Traction Power Supply, OHE system, ROCS system and SCADA etc., the Contractor shall produce Manuals covering the additional provisions, over and above the various existing Codes and Manuals of Indian Railways in respect of the Operation and Maintenance requirements of various assets created under the Contract.

14.5.2 With reference to the requirements as above:

(1) The Contractor shall produce manuals for all equipment and manufactured items and sub-systems, supplied and created under the Contract, for their efficient operations and maintenance. These shall include, but not be limited to, the following manuals:

a. Maintenance of Traction Power Supply Equipment;

b. Maintenance of Traction OHE Equipment's;

c. Maintenance of Traction ROCS Equipment;

d. Maintenance of Traction SCADA System;

e. Maintenance of Buildings & Structures including lighting etc.;

f. Earthing & Bonding, Lightning and Surge Protection System

g. System / Sub-System Manuals- A comprehensive description of all system principles at block diagram level.

h. Operating/User Manuals - broken into as many sub-sections as necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system.

i. Workshop Manuals - Installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction/installation drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

j. Software System Manual - for each software package and each piece of equipment which incorporates Programmable Device(s), licensed copies of CD/DVD/Hard Disc of application and peripheral software along with write up on software features, instructions for configuration, working of software and procedures for taking out report and data in the form of instruction manual/guide.

k. As-Built Documents - all wiring diagrams and circuits, equipment layout, terminal and cable listing and including such external equipment as may be necessary for completeness.

(2) Maintenance Manuals shall contain the following but not limited to;

a. Technical description, principle, installation procedures etc., of each system and sub-system of equipment installed to ensure that the Employer's technical staffs fully understand the scope and facilities provided.

b. Diagrammatic drawings of each system indicating principal components and items of equipment

c. Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment

d. Manufacturer's service manual for each major item of equipment, assembled specifically for the project including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance Program.

e. Procedures for fault localization and isolation

f. Maintenance procedures and their periodicity. The contractor must give list of Items to be checked, adjustments to be made, safety checks to be performed and frequency of maintenance for each item of the sub-system/equipment. These maintenance Schedules should be compiled in the form of a register and shall be kept at stations for recording of the maintenance done by maintainer. It should lead to computerization of the maintenance activities.

g. Tools and Plant needed for maintenance of different Equipment provided in the Works.

h. Configuration Manual for all equipment, wherever required.

I. All test results conducted on the relevant equipment whether at the manufacturer's place or at site; and

II. Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items, which may involve extended deliveries.

(3) The Operating / User Manuals and Maintenance Manuals of Systems/Sub Systems suitable for use at technician level, shall be prepared in both English and Hindi languages unless otherwise instructed by the Engineer.

(4) The Contractor shall provide 6 copies (hard copy) of all Manuals along with editable (and pdf) electronic version for the use of the Employer's Staff / Engineer.

(5) The Contractor shall maintain all Manuals in an updated condition throughout the Contract Period, wherever applicable.

(6) O&M Manuals and drawings as submitted by the Contractor shall be updated by him during the Defects Notification Period, if required and shall be re-submitted to the Engineer for review without any extra cost to the Employer.

14.6 MAINTENANCE PLAN

14.6.1 While Operation & Maintenance Support Plan take care of day to day operation and maintenance of the systems/sub-systems, the Maintenance Plan is designed to put the maintenance practices on sound footing for proper upkeep of the systems. The Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for review at least 12 months before start of Defect Notification Period.

14.6.2 The Maintenance Plan shall describe, but not limited to, the following:

(1) Maintenance philosophy and approach,

(2) All necessary tasks for first line, second line, third line and corrective maintenance,

(3) Frequency of each maintenance task,

(4) Employer's and Contractor's proposed maintenance regime for maintenance,

(5) Maintenance Schedules (Daily, Weekly, Monthly) detailing maintenance task for each maintenance team member;

14.6.3 The Maintenance Plan shall be aligned with the Employer's maintenance policy.

14.7 MAINTENANCE SCHEDULES

14.7.1 The Contractor shall prepare the Maintenance schedule for each item/equipment required to be maintained. The schedule should give the details such as the frequency of maintenance, the items to be maintained, the tolerances permitted and the safety checks to be performed. The Contractor shall submit the Maintenance Schedule to the Engineer for review.

14.7.2 In addition to the above, the Contractor shall include in the Maintenance Schedule the following information:

(1) The equipment, sub-systems covered in the task,

(2) Step by step procedure to carry out the task,

(3) Tools and test equipment required for each task,

(4) Diagrams and flowcharts by illustration, if applicable,

(5) Adjustment procedures for all field adjustable units,

(6) Recovery procedures, if applicable,

(7) Precautions to be followed by maintenance personnel and

(8) Estimated duration and manpower required;

(9) Test to be conducted on System/Sub-System;

(10) Do's & Don'ts

14.8 MONTHLY MAINTENANCE MEETING

14.8.1 The Contractor shall attend the Monthly Maintenance Meeting with the Engineer to discuss the maintenance matters during the Defect Notification Period. The dates and agenda of the meeting shall be agreed with the Engineer.

14.9 SOFTWARE SUPPORT

14.9.1 The Contractor shall provide full support to the Employer and the Engineer for all computer programs, which are supplied by the contractor under the scope of this Contract.

14.9.2 The Contractor shall provide to the Employer and the Engineer one (1) copy each of the software packages with the same software products as those that the Contractor intends to use for the project, inclusive but not limited to programs for business administration, project management, design development etc. The Contractor shall utilize a shared electronic document management system with the Engineer and the Employer which shall be web / internet based.

14.9.3 The Contractor shall provide all tools, equipment, manuals and training necessary for the Employer/Engineer to maintain, re-configure and to make proper use of all the software provided under the Contract. This shall include supply of any specified development tools required for maintenance of the software, including but limited to editors, compliers and linkers.

14.9.4 If any software is developed under the Contract or used by the Contractor for the purposes of storing or utilizing records over which the Contractor or a third party holds title or other rights, the Contractor shall permit or obtain for the Employer and Engineer the right to use the Software free of any additional charge, together with any modifications, improvements and developments thereof, for the purpose of the reinstatement, extension, repair, modification or operation of the Works, or any part thereof, or to avoid any Dispute.

14.9.5 The Contractor's permission referred to above shall be given, inter-alia, to enable the Employer to disclose (under conditions of confidentiality satisfactory to the Contractor) program and documentation for a third party to undertake the performance of services for the Employer in respect of such program and documentation.

14.9.6 The Contractor shall submit a Software support plan at least ninety (90) days before commencement of software installation. This plan shall require the Contractor to provide all changes, error fixes, updates, modifications, amendments and new versions with the updated instructions, and Operation and Maintenance Manuals of the program as required.

14.9.7 The Contractor shall submit all new versions to the Engineer for review at least two (02) weeks prior to their installation. The Engineer will not be obliged to use any new version and this shall not relieve the Contractor of any of its obligations.

14.9.8 The Contractor shall:

(1) ensure that all new versions are fully tested & commissioned at site and validated on the simulation and development system and reviewed without objection by the Engineer prior to installation;

(2) All new version of software shall be accompanied by a release note containing the following details:

a) Version number

b) Modifications made to the previous version

c) Check sum;

d) Updated Operation & Maintenance manuals

14.9.9 The new Versions of any program shall not result in any non-conformance with the Specification or degrade the performance or have adverse impact on the System. Any effect upon the performance or operation of the computer-controlled system that may be caused by a new version shall be brought to the Engineer attention including updating the files to suit new version.

14.9.10 The Employer reserves the right to use other Software in connection with the Works.

(End of Chapter 14)

CHAPTER 15 - APPENDICES

This Chapter includes a number of Appendices as listed below:

APPENDIX 1 –MONTHLY PROGRESS REPORT

APPENDIX 2 - DRAWINGS AND CAD STANDARDS

APPENDIX 3 - DESIGN CERTIFICATES

APPENDIX 4 - TEMPORARY WORKS

APPENDIX 5 - REQUIREMENTS FOR CONSTRUCTION

APPENDIX 6 - ENVIRONMENT PROTECTION REQUIREMENTS

APPENDIX 7 - PMIS REQUIREMENTS AND PROCEDURES

APPENDIX 8 – LIST OF LEVEL CROSSING

APPENDIX-9: ENVIRONMENTAL, SOCIAL, HEALTH AND SAFETY PROGRESS REPORTS

APPENDIX 10 – LIST OF BRIDGES

APPENDIX 11 – LIST OF TRANSMISSION LINES 66kV AND ABOVE

APPENDIX 12 – LIST OF POWER CROSSINGS 33KV AND BELOW

APPENDIX 13 – SUBCONTRACTOR FOR ROCS SYSTEM

APPENDIX 14 – CONTRACTOR'S KEY PERSONNEL

APPENDIX 15 – KEY DATES

APPENDIX-1: MONTHLY PROGRESS REPORT

1. GENERAL

a. The Contractor shall prepare and submit Monthly Progress Reports in at least 5 Copies (hard) in English as well as in Electronic Medium or CD covering all aspects of the execution of the Works.

b. Monthly Progress Reports shall be delivered to the Engineer by the 7^{th} day of the month reporting the progress of the work performed from 1^{st} day of the previous month till the Last day of previous month to which the Monthly Progress Report relates.

c. The Monthly Progress Report shall contain evidences that documents and supports indicating the progress of the Works, as stated in the interim Certificate of Payment, to the satisfaction of the Engineer.

d. The reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work to be accomplished and shall provide the Engineer with a sound basis for identifying problems and deviations from planned work and for making decisions.

e. The results of quality audits shall be summarized in the Contractor's monthly reports.

f. Monthly Progress Report format, as approved by the Engineer shall comprise the following information:

   i. Executive Summary

   ii. Achievements of the month

   iii. Top 10 significant issues

   iv. Health, Safety and Environment Compliance

   v. Quality Assurance Issues

   vi. Design / Engineering Status

   vii. Procurement Status Report (i.e. statement with PO date, Manufacturer name, LC date, FAT test date, Shipping / Dispatch date, Delivery date)

   viii. The Status (Manufacturing / Supply / Installation / Testing) of stages of Works i.e. Physical Progress of activities

   ix. Work Program Progress status

   x. Any delay/ shortcomings from the Targets, constraints and Measures Proposed

   xi. Financial Progress Status

   xii. Progress marked on 3 month's rolling Program

   xiii. Assistance Required if any

2. SAFETY

A review of all safety aspects during the month including reports on all accidents and actions proposed to prevent further occurrence including details of safety training and drive conducted during the period and proposed in coming months.

3. FINANCIAL STATUS

(1) A narrative review of all significant financial matters and actions proposed or taken in respect of any outstanding matters.

(2) A spread sheet indicating the status of all payments due and made including recoveries, if any.

(3) A report of the status of any outstanding claims even if these are NIL.

(4) The report shall in particular provide interim updated accounts of continuing claims.

4. PHYSICAL PROGRESS

(1) It shall describe the status of work performed in descriptive form, significant accomplishments, including critical items and problem areas including current and anticipated delaying factors and their impact, corrective actions taken or planned and other pertinent activities and shall, in particular, address interface issues with all agencies involved, problems and resolutions during the period or anticipated.

(2) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Program.

5. PROGRAM UPDATE FOR ENTIRE PROJECT

(1) Program updating shall include:

a. The monthly program update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the last day of the month and expected activity completion based on current progress.

b. The Program update shall be accompanied by an activity report and a narrative statement.

c. The narrative statement shall explain the basis of the Contractor's submittal:

i. Early Work and baseline submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Key Dates as specified in Chapter- 4:" Project Program Requirements" of this GS

ii. Updated detail program submittals – state in the narrative the Works actually completed and reflected along critical path in terms of days ahead or behind allowable dates, specific requirements of narrative are:

- If the updated detailed work program indicates an actual or potential delay to Contract Completion date or Milestones, identify causes of delays and provide explanation of work affected and proposed corrective action to meet Milestones or mitigate potential delays.

- Identification of any deviation from previous month's critical path.
- Identify by activity number and description, activities in progress and activities scheduled to be completed.
- Discuss variation work order items, Value Engineering items, if any.

b. Program Status which shall:

i. Show Works Program status up to and including the current report period, display cumulative progress to date and a forecast of remaining work.

ii. Be presented as a bar-chart in size A3 or A4.

c. The activity variance analysis which shall analyze activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Program.

6. THREE-MONTH ROLLING PROGRAM

The three month rolling program shall be issued on a monthly basis.

7. PROCUREMENT REPORT

(1) A summary of all significant procurement activities during the month, including action taken to overcome problems.

(2) A report listing major items of plant and material which will be incorporated into the Works.

(3) The items shall be segregated by type and the report should show as a minimum the following activities:

a. Purchase order date - scheduled/actual;

b. Manufacturer/supplier and origin;

c. Letter of credit issued date;

d. Manufacturer/supplier ship date - scheduled/actual;

e. Method of shipment;

f. Arrival date in India- scheduled/actual.

8. PRODUCTION AND TESTING

(1) A review of all production and manufacturing activities during the month.

(2) Summaries of all production and manufacturing outputs during the month together with forecasts for the next month.

(3) Review of all testing activities (both at Site and at the manufacture's premises) during the month

9. DEPLOYMENT OF MANPOWER MATERIAL AND EQUIPMENT AT SITE

(1) Detail showing the extent of deployment of manpower, equipment and stock of important construction material utilized at the Site.

(2) A list of major construction equipment used on the Project during the reporting period and any construction equipment idle during the reporting period.

(3) A list of all major or critical material and equipment, indicating current availability and anticipated job Site delivery dates.

(4) The total number of personnel by craft actually engaged in the work during the reporting period, defined separately as to office, supervisory, and field personnel.

(5) A manpower and equipment forecast for the upcoming twenty eight (28) days, stating the total number of personnel by craft, defined separately as to office, supervisory and field personnel.

(6) Changes or additions to Contractor's supervisory personnel that occurred from the preceding Monthly Progress Report. The Monthly Progress Report shall accompany the Application for Payment and monthly schedule update

10. PROGRESS PHOTOGRAPHS AND VIDEOGRAPHY

(1) The Contractor shall provide monthly progress photographs to demonstrate the progress of the works.

(2) Two sets of photographs shall be provided on electronic storage device with two sets of Colour prints of 175 mm x 125 mm size.

(3) All Photographs shall be labeled with the location and the date.

(4) The Contractor shall ensure that no photography is permitted on the Site without the consent of the Engineer.

(5) Construction/Installation activities working of machinery, weather effects or any occasion advised by the Engineer shall be video graphed. The recording shall be done or converted to .avi format and presented in electronic storage device with appropriate voice recording describing the event.

(6) The Contractor shall provide to the Employer for every calendar quarter, a video recording, which will be compiled into a 3 (three) – hour compact disc or digital video disc, as the case may be, covering the status in that quarter giving progress of works. The first such video recording shall be provided to the Employer within 7 (seven) days of the LOA of the Contract and thereafter, no later than 15 (fifteen) days after the close of each quarter.

11. QUARTERLY AND YEARLY REPORT

(1) The Contractor shall also submit Quarterly Progress Reports covering all aspects of the execution of the Works to the Engineer reporting the progress of the work performed between previous Quarters/Year.

(2) The Progress Report shall contain evidences that documents and supports indicating the progress of the Works, as stated in the interim Certificate of Payment, to the satisfaction of the Engineer.

(End of Appendix-1)

APPENDIX-2 –DRAWINGS AND CAD STANDARDS

1. GENERAL

(1) The purpose of this chapter is to define the Drawing and CAD standard and their standards for submissions, the acceptable file formats and content formats to help development of coordinated documents and drawings in common formats.

(2) The titles & numbering, scale of drawings shall be as per relevant Indian Railway Manual/ IS Standards as well as above CAD standards as mutually agreed by the Contractor and the Engineer.

(3) Drawings shall use as far as possible, symbols used internationally.

(4) All legends, notes on drawings and schedules of material shall be in English and shall be prepared in the metric system

(5) The Contractor shall submit six hard copies and a soft copy of the Detailed Design and drawings including calculations for review by the Engineer. After receipt of "Notice of No Objection" from the Engineer, the Contractor shall submit six (6) copies of the Design and / or Drawings for the use of the Engineer***.***

2. SOFTWARE

(1) The following software compatible for use with Intel-Windows based computers shall be used unless otherwise stated, for the various electronic submissions required:

Document Type	Electronic Document Format
AutoCAD Graphics	CorelDraw, Ver. 12.0/ AutoCAD 2011 or latest versions
Photographic	Adobe Photoshop CS2 or latest version
Desktop Publishing	Page Maker 7.0 or latest version
CAD Drawings	AutoCAD 2011 or latest version.

(2) For electronic file submission one copy shall be submitted unless otherwise stated on CD-ROM media. The media shall be CD-R and the recording method shall not allow any further changes to the recordable disk.

(3) Internet File Formats/Standards:

a. The following guidelines shall be followed when the Contractor uses an internet browser as the communication media to share information with the Engineer /Employer. All the data formats or standards must be supported by Microsoft Internet Explorer version 7 or above running on Windows XP or above. The Contractor shall comply with them unless prior consent is obtained from the Engineer for a different data format:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF or JPEG

Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM) and DWG
Video	Window video (.avi)
Sound	Wave file (.wav)

(4) The following states the standards to be used on the internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained from the Engineer for a different standard:

Function to be implemented	**Standard to be complied with**
Database connectivity	Open Data Base Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hyper Text Markup Language (HTML)

3. TITLE BLOCKS AND DRAWING NUMBERING

a. The Contractor shall adopt a title block similar to that used in the drawings for all the Contractor's documents prepared under the Contract.

b. Each document shall be uniquely referenced by a document number and shall define both the current status and revision of the drawing.

c. The drawing numbers will be in the digits/format as defined Below:

Like PWL – SNP to define the section between Palwal to

Sonepat,

i. X/X/XX/XXX-XXX/XXXX-X i.e P/4/OL/ PWL-SNP/0021-A

d. The current status of each document shall be clearly defined by the use of a single letter code as follows:

i A single letter character denoting the status of the drawings e.g.

T Tender Design

P Preliminary Design

W Working Drawing

M Manufacturing Drawing

S Site Drawing

D Shop Drawing

A As Built Document

ii A single digit code denoting the contract number (for the whole line)

1 Civil / Track Works from ______to ______

3 Systems Works

4 Traction System – PSI

5 Traction System – OHE/ROCS

6 SCADA

iii A two (2) letter code denoting the type of System Works or system elements e.g.

CG	General Works
ST	Stations
TU	Tunnels
AL	Alignment
RW	Right - Of - Way
CE	Civil Engineering (earth work, culverts, pedestrians, foot bridge, agricultural underpass, survey, track drainage, etc.)
RB	Railway Bridges
RO	Road Over Bridges
RU	Road Under Bridges
EC	Environmental Control System
UT	Utilities (Power, Gas, Telecoms, Electric, Water supply, Sewer lines)
SE	Structural Engineering (structural steel, reinforced concrete etc.)
GE	Geotechnical Engineering (Instrumentation, ground treatment, de-watering, etc.)
AR	Architecture
LS	Landscape
EE	Electrical Engineering (low voltage)
ME	Mechanical Engineering (ventilation, fire fighting, plumbing)
PS	Power Supply (high voltage, traction power)
SG	Signalling (train control)
CM	Telecommunications,
TK	Track-work
TM	Traffic Management (Roads, Pavements)
WS	Water Supply
SW	Switching Stations
GS	Grid Sub-station
TS	Traction Sub-station
TL	Transmission Line
SC	SCADA system
OL	Overhead Line Equipment

iv Section

A Unique & digit Code for identifying Station from – to

Like PWL – SNP to define the section between Palwal to Sonepat

v Location Code (3 / 4 digit)

Unique Location code shall be essential to identify the location of

Installation, station code/ TSS code/ OCC code

vi A unique Three (3) digit number (from 001 to 999), identifying each drawing.

vii A single letter (A to Z except I and O) denoting the sequence of revision to the drawing. The initial drawing issue will carry a revision letter "A".

Example: Drawing Title Block:

Status	Drawing No:	Revision:
P	4 / SC / PWL-SNP / SNL/235	B

(Note: The comparable computer reference is “4SC PWL-SNP -0235B”)

Denotes:

(P) Traction System/SCADA/ Section between PWL-SNP / Location KHJ/Drawing’ identifying Number 235, Revision B.

4. TYPES OF DRAWINGS

Types of Drawing such as 'Working drawings', Layout Drawings, Equipment Drawings, Shop Drawings, Reference Drawings and Manufacturing Drawings and As Built Drawings.

5. COMPUTER AIDED DESIGN AND DRAWING (CAD) STANDARDS

The main objectives of the CAD standards are as follows:

a. To ensure that the CAD data files produced for project are coordinated and referenced in a consistent manner.

b. To provide the information and procedures necessary for a CAD user from one discipline or external organization to access (and use as background reference), information from a CAD data file prepared by another discipline or external organization.

c. To standardize the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.

d. To establish procedures necessary for the management of CAD data files.

e. To ensure all contractors use 'Model space' and 'Paper space' in the production of their CAD files.

f. To facilitate co-ordination between contractors, all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods.

g. The intent of the issue of digital information is to aid the interface design by others.

h. The definitive version of all Drawings shall always be the paper or polyester film copies which have been issued by the Contractor or organization originating the drawing and also held in the Project’s electronic document control system.

i. Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.

j. Any contractor or organization making use of the CAD data from others shall be responsible for satisfying him that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it, provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

k. In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings.

l. Figured dimensions shall always be taken as correct where discrepancies occur.

6. TERMINOLOGY AND ASSOCIATED STANDARDS

Any terminology used within this section that is ambiguous to the user shall be clarified with the Engineer. Indian national and Indian Railways standards are to be used in principle as a guide for drawing practice, convention, CAD data structure and translation.

7. PAPER DRAWINGS

For the Project "Paper" drawings are considered to be the main vehicle for the receipt and transmittal of design and production information, typically plans, elevations and sections.

8. CAD QUALITY CONTROL

a. Random CAD Quality control audits will be carried out by Engineer on all CAD media received and transmitted.

b. These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organization); however compliance with project CAD and Drawing Standards shall be checked.

c. In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place.

d. A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

9. CAD DATA TRANSFER MEDIA AND FORMAT

When CAD data is received and transmitted between the Engineer and the Contractor, the media shall be as follows:

a. All CD-R/RW and DVD+/-R must be labeled on the data shield with:

   i. Name of Company

   ii. Project Title

   iii. Drawing Filenames

   iv. Disk No. / Total No. of disks

b. All media shall be submitted with a completed form (CAD Disk)

c. The CAD transmittal format from contractors shall be in AutoCAD (version 2011) or latest.

10. REVISIONS

All 'Revisions', 'In abeyance' and 'Deletions' shall be located on a common layer which can be turned on or off for plotting purposes.

11. BLOCK LIBRARIES, BLOCKS AND NAMES

a. All Symbols produced as CAD Cells shall conform to Indian or International Standards.

b. All blocks created shall be primitive (i.e. NOT complex) and shall be placed absolute (i.e. NOT relative).

c. The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description.

d. The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

e. All blocks of a common type, symbols or details should initially be created within a CAD "Model Space File" specifically utilized for that purpose. These files will be made available on request by Engineer.

f. All blocks created will typically be 2D unless 3D is specifically requested. They shall have an origin at a logical point located within the extents of each block's masked area or volume.

12. CAD DIMENSIONING

a. Automatic CAD Dimensioning will be used at all times.

b. Any dimensional change must involve the necessary revision to the model space file.

c. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

13. CAD LAYERING

a. All CAD elements shall be placed on the layers allocated for each different discipline.

b. The Contractor's layer naming convention shall be submitted for the Engineer's approval.

14. GLOBAL ORIGIN, LOCATION AND ORIENTATION ON THE ALIGNMENT DRAWINGS

a. Location or plan information in "Model Space" files shall coincide with the correct location and orientation on the project grid for each specific contract.

b. Location plans shall have at least three setting out points shown on each CAD

"Model Space" file. Each setting out point shall be indicated by a simple cross-hair together with related East and North co-ordinates.

c. The Contractor shall establish the three setting out co-ordinates for their respective works which will then be used by the Contractor and the sub-contractor(s), if any.

15. LINE THICKNESS AND COLOUR

To assist plotting by other users, the following colour codes will be assigned to the following line thickness / pen sizes:

Colour	Code No.	Line Thickness
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

16. CAD UTILIZATION OF 2D AND 3D FILES

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualization process (i.e. architecture, survey and utilities).

(End of Appendix-2)

APPENDIX-3: DESIGN CERTIFICATE

The Contractor shall submit the Design Certificate with all Design Documents and Drawing. All the Drawings shall be printed with Design certificate signed and issued by Project Manager of Contractor.

DESIGN CERTIFICATE

This Design Certificate refers to Submission No. ....which comprises:

[*Design Package No. .... / the Detailed Design and Drawing Submission No. .... / Technical Submission No .....] in respect of:

[description of the Works to which the submission refers]

The contents of this submission are scheduled in Section A below.

The documents scheduled in Section B below, for which a Notice of No Objection has been issued, are of relevance to this submission.

DESIGNER'S STATEMENT

We hereby certify that:

a) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the specifications requirements and. [see note 1 below];

b) The outline designs, design briefs and performance specifications of those elements of the Works as illustrated and described in the documents scheduled in Section A below comply with the specifications requirements and. [see note 1 below];

c) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements specifications requirements and...... *[see note 1 below]* except in the following respects:

(i) ....(to be completed by Contractor/Designer)

(ii) (etc.)

d) An in-house check has been undertaken and completed to confirm the completeness, adequacy and validity of the design of the Works as illustrated and described in the documents scheduled in Section A below;

e) All necessary and required approvals relating to the design of the Works, as illustrated and described in the documents scheduled in Section A below, have been obtained and copies of such approvals are annexed in Section C below;

AND (in the case of a submission covering a part of the Works only):

f) All effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of those parts.

Signed by 'Authorized Representative'
(for Designer)
Name
Position/ Designation
Date

CONTRACTOR'S CERTIFICATION

This is to certify that all design has been performed utilizing the skill and care to be expected of a professionally qualified, competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us.

Signed by 'Authorized Representative' (for Contractor)

Name

Position/Designation

Date

<u>Note 1</u>

The Contractor shall insert one of the following, as applicable:

(i) The Contractor's Technical Proposals

(ii) The Contractor's Technical Proposals and Design Packages Nos.............for which a Notice of No Objection has been issued.

(iii) Design Packages Nos............. for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Detailed Design

<u>Section A</u>

Submission no. ..... comprises the following :

Drawings : *(Title, drawing number and revision)*

Documents: *(Title, reference number and revision)*

Others:

Section B

Documents for which a Notice of No Objection has been issued and which are of relevance to this Submission No. .....

Document:

Submitted with

[*Design Package No ..../

Detailed Design Submission No…………/

Good for Construction Drawing Submission No. ..../

Technical Submission No. ..…………/

Date of Issue of Notice of No Objection

The Contractor is required to provide this information in respect of each document in Section B

(Delete as appropriate)*

Section C

[Contractor to attach copies of necessary and required approvals]

(End of Appendix-3)

APPENDIX-4: TEMPORARY WORKS

1. SCOPE

(1) All necessary Temporary Works required for the realization of the works such as Temporary Facilities and Temporary Utility Services including labour camps shall be provided & maintained by the Contractor for his own use, for his sub-contractors, the Engineer & the Employer unless otherwise authorized by the Engineer. The standard conditions applying to Temporary Power Supply to any Works Area by the Contractor for its Site facilities are detailed but not limited to, as under. To facilitate Permanent works The contractor would be required to establish temporary Installation may include but not limited to:

a. Site office, Ware house , Material stock area, fencing of site,

b. Lighting, water and power distribution, cabling and earthing at site

c. Construction Equipment supply , mobilization and installations

d. Labour camp

e. chartered/ unchartered utility Diversions

(2) The Contractor shall take adequate precautions in the provision & the maintenance of the Temporary Power Supply to Temporary Works and to Works areas. To establish temporary Utility power, the work should be carried by the skilled electrician under the supervision of qualified engineer and the site shall be monitored by the qualified engineer to ensure electrical safety at site.

2. GENERAL

(1) The Contractor shall nominate a qualified electrical supervisor whose name and qualifications shall be submitted in writing to the Engineer for review, who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site.

(2) The Contractor shall not install or operate any temporary electrical systems on the Site until this electrical engineer is appointed and has commenced duty.

(3) The name and contact telephone number of the qualified electrical engineer shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.

(4) The Contractor shall submit details of all base electrical circuits, characteristics and the equipment for all temporary electrical installations together with details of the temporary electrical equipment(s) to the Engineer for his consent,

(5) Temporary electrical Site installations and distribution systems shall be in accordance with the rules and regulation applicable for and/or applied by:

a. The local electrical company supply rules;

b. Wiring regulations;

c. Distribution of electricity on construction and building sites;

d. Distribution assemblies for electricity supplies for construction and building sites;

e. Regulations for fire safety norms and requirements for civil works; and

f. Any other applicable Indian standards and regulations.

2.1 Material, Appliances and Components

All material, appliances and components used within the distribution system shall comply with Indian standards.

2.2 Design Considerations

(1) Distribution equipment utilized within the temporary electrical distribution system shall incorporate the following features:

a. Flexibility in application for repeated use;

b. Suitability for transport and storage;

c. Robust construction to resist moisture and damage; and

d. Safety in use.

(2) All cabling shall be run at high level wherever possible and be firmly secured to ensure it does not present a hazard or obstruction to people and equipment.

2.3 Mains Voltage

"SHE Manual" of HRIDC provided in "Reference Documents – Part 2, Section VII-4 of Bidding Documents" stipulates certain voltages for different works. In case of conflict of provisions regarding voltage under this Appendix, those specified in the SHE Manual shall prevail.

(1) The Site mains voltage shall be 400V/ 3 phases 4-wire system 50 Hz.

a. Single phase voltage shall be 230V supply.

b. Reduced voltages shall conform to Indian Standards.

(2) The following voltages shall be adopted for typical applications throughout the distribution systems:

a. Fixed plant – 400V/ 3 phase;

b. Movable plant fed by trailing cable – 400V /3 phase;

c. Installations in Site buildings - 230V/240V /1 phase;

d. Fixed flood lighting - 230V/240V 1 phase;

e. Portable and hand held tools – 12V, 24V or 36V /1 phase;

f. Site lighting (other than flood lighting) – 12V, 24V or 36V /1 phase; and

g. Portable hand-lamps (general use) – 12V, 24V or 36V /1 phase.

(3) Protection of Circuits

a. Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults.

b. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

c. Discrimination between circuit breakers, circuit breakers and fuses shall be in accordance with the Indian Standards.

2.4 Earthing

(1) Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

(2) Earthing systems shall conform to the following standards:

a. Wiring regulations;

b. Guide for safety in AC substation grounding.

c. Indian Electricity Rules

2.5 Plugs, Socket Outlets and Couplers

Low voltage plugs, sockets and couplers, as well as the high voltage couplers and 'T' connections shall be colour coded in accordance with, and conform to Indian Standards. All the Pugs and sockets used at construction site shall be IP 65 protected with Residual Current Circuit Breaker RCCB/ Earth Leakage Circuit Breakers (ELCB) to prevent Leakage of current and electrocution in Compliance to Indian Electricity Rule.

2.6 Cables Used for Temporary Works

(1) Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required.

(2) Temporary Supply cables shall be minimum 3-core (P + N + distinctly colored PE) for single phase power distribution and in accordance with Indian Standards with TNS Earthing. Similarly. the cable used for 3-phase power distribution shall also conform the TNS earthing system. Earthing/ armoured wire shall be retained at zero potential. All the cables used at site will be joint-less. Joints if any shall be made through proper Jointing Kit in IP 65 enclosure to prevent accidental touch and electrocution of the staff/ public. All the cables laid underground hat worksite shall be armoured. All the cables shall conform BIS and have Marking conforming to standards. No cable with damaged insulation shall be used and the cable damaged if any shall be removed immediately and ensured by the Project Manager.

(3) For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to Indian Standards as well as one of the following specifications appropriate to the duties imposed on it:

a. Flexible cables for use at mines and quarries;

b. Rubber insulated cables for electric power and lighting; and

c. Insulated flexible cords and cables.

(4) All cables which have a voltage to earth exceeding 65V (except for supplies from welding transformers to welding electrodes) shall be metal sheathed and/or armoured which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.

(5) Armoured cables having an over-sheath of polyvinyl chloride (PVC) or oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.

(6) Cables with an applied voltage to earth exceeding 12V but not normally exceeding 65V, shall be insulated and sheathed with a general purpose or heat resisting elastomer.

(7) The Welding earthing cable shall be insulated and conform to relevant standards. Other than the insulated Cables shall not be used at work site to avoid any leakage and electrocution at worksite.

2.7 Lighting Installation

(1) Where Site works are required during the night, the lighting circuits shall be run separate from other sub-circuits and shall be in accordance with Indian Standards. Contractor shall submit method statement for "work during night" for review by the Engineer.

(2) Voltage shall not exceed 55V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.

(3) Luminaries shall have a degree of protection not less than IP 54.

(4) In particularly onerous environments where the luminaries are exposed to excesses of dust and water, a degree of protection to IP 65 shall be employed.

(5) The Contractor shall provide a minimum lighting level of 200 lux by localised lighting in all areas where required for carrying out the works.

(6) Wherever a risk of damage may occur, luminaries shall be mechanically protected against impact damage by use of wire guards or other such devices.

2.8 Electric Motors

(1) Totally enclosed fan cooled motors to Indian Standards shall be used.

(2) Motor control and protection circuits shall be as stipulated in Indian Standards.

(3) Emergency stop switches shall be provided for all machinery.

2.9 Inspection and Testing

Electrical installations on Site shall be inspected and tested in accordance with the requirements of the wiring regulations.

2.10 Maintenance

(1) Regular maintenance and checking of control apparatus and wiring distribution systems shall be carried out by an engineer or electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems.

(2) All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection and the recommended inspection period.

2.11 Metering

The Contractor shall install and register a separate energy meter for each supply of electricity from the applicable suppliers. The Contractor shall pay all required charges for the supplied electric energy.

(End of Appendix-4)

APPENDIX-5: REQUIREMENT FOR CONSTRUCTION

1. THE SITE

1.1 The Site details and locations are defined in the Particular Specifications and in Section VII-3: Drawings and Reference Document of the Bid Document.

1.2 Use of the Site and Work Areas

1.2.1 The Site or Contractor's Temporary Facilities including Contractor's equipment shall not be used by the Contractor for any purpose other than for carrying out the Permanent or Temporary Works or Contractor's Temporary Facilities except that with the consent of the Engineer in writing.

1.2.2 The Employer shall hand over the Site to the Contractor free of encumbrances as per the agreed schedule. Once the Site is handed over to the Contractor, its integrity, safety and security etc. shall be the responsibility of the Contractor until the issue of Taking Over Certificate unless otherwise directed by the Engineer.

1.2.3 The location and area of material stacking and each stockpile of material including excavated material within the ROW shall be subject to approval by the Engineer. Stockpiles of material and stacking of steel etc. shall be maintained at all times in a stable condition.

1.2.4 In case spare land is available with the Employer the same can be handed over to the Contractor free of cost for the purpose of establishing temporary construction depot(s). However, whenever Employer requires this portion of land back, the same shall be handed over to the Employer with a month's notice at no extra cost / compensation to the Contractor.

1.3 Access to the Site

1.3.1 The Contractor shall make its own arrangements, at **their own cost,** subject to the consent of the Engineer, for access required to the Site.

1.3.2 The existing access roads, if used by the Contractor for transport of his men, material and equipment shall be maintained by the Contractor to a satisfactory level to allow uninterrupted flow of traffic including the public traffic otherwise using these roads including cleanliness.

1.3.3 In addition, the Contractor shall ensure that access to every portion of the Site is continuously available to the Employer's Personnel and the Engineer and other entities authorized by the Employer / Engineer.

1.4 Access / Egress through Work Areas

The Contractor shall be responsible for ensuring that any access or egress through the Work Areas boundaries are controlled so that no disturbance to residents or damage to public or private property occur as a result of the use of such access or egress by his employees and Sub-Contractors.

1.5 Survey of the Work Areas

In addition to the validation of the data provided by the Employer and additional survey, as considered necessary by the Contractor, the Contractor shall carry out survey to identify any encumbrance infringing the Permanent Works and shall advise the Engineer accordingly. The survey shall be carried out before the site clearance, wherever possible and in any case prior to the commencement of the Work in any Work Areas. The survey shall be carried out by the Contractor and agreed with the Engineer.

1.6 Temporary Fencing and Signboards

1.6.1 The Contractor shall erect hoardings, temporary fences and/or gates around the Work Areas specifically near the populated areas to prevent entry by unauthorized persons to his Work Areas as long as they are deemed to be necessary. The Contractor shall issue, all his personnel including the personnel working with sub-contractor(s), identity cards for entering the Work Areas. Necessary arrangements to ensure that no unauthorized person enters the Work Areas and shall be made by the Contractor by way of posting of security guards. Use of hoardings / temporary fencing / signboards etc. shall not be permitted for any kind of advertisement / publicity etc., without the consent of the Engineer.

1.6.2 For executing the work adjacent to running traffic areas, the Contractor shall erect fences and gates around its areas of operations to prevent accidents as well as post competent flagmen/ guards. The Contractor shall submit proposals for the fencing of the Work Areas to the Engineer for review. No Work shall be commenced in any Works Area until the Engineer has been satisfied that the fencing installed by the Contractor is sufficient to prevent any unauthorized entry.

1.6.3 Project signboards shall be erected at the Site 7 days prior to the commencement of the construction activities of the relevant Work Area. The type, size and locations of project signboards shall be agreed by the Engineer before manufacture and erection of the signboards.

1.6.4 The consent of the Engineer shall be obtained before hoarding, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in positions after the issue of Taking-Over Certificate shall be repaired and repainted as instructed by the Engineer.

1.6.5 Hoarding/fencing can be reused after removing from one place to other locations / sites provided they are in good condition and consented by the Engineer.

1.6.6 Damage/worn-out fencing/hoarding shall be replaced by the Contractor within 24 hours. Engineer's decision regarding need for replacement shall be final and binding and if no action is taken by Contractor, the same shall be got done by the Engineer and cost of any repair shall be deducted by the Engineer from any payment due to the Contractor.

1.6.7 The types, sizes and locations of project signboards shall be agreed with the Engineer before manufacture and erection. Other advertising signs shall not be erected on the Site.

1.6.8 Hoardings, fences, gates and signs shall be maintained in good order by the Contractor until the completion of the Works, whether such hoardings, fences, gates and signs have been installed by the Contractor or by others and transferred to the Contractor during the period of the Works.

1.6.9 All hoardings, fences, gates and signs installed by the Contractor shall be lit during night or low visibility as required and advised by the Engineer and removed by the Contractor upon the completion of the Works, unless otherwise directed by the Engineer.

1.7 Clearance of the Site

All Temporary Works shall be removed by the Contractor upon issue of the Taking Over Certificate except the Temporary Facilities with necessary utility services, required for completing his obligations after the issue of Taking-Over Certificate unless otherwise directed by the Engineer. The Contractor shall dismantle and remove all Temporary Works and the land in which the Temporary Works have been located, shall be properly treated, to complete the Works as shown in the Construction Drawings.

2. CONSTRUCTION-PRECAUTIONS

2.1 Precautions While Working In Close Proximity of Existing Indian Railway/DFCCIL Track

a. General

i Prior to the commencement of construction operations, the Contractor shall obtain all necessary clearance(s) from the concerned authorities.

ii Any construction activity involving the existing embankment/formation/ running track of the Indian Railways shall be carried out only with the prior specific authorization of the Engineer.

b. Works being executed outside running lines are further divided into following 3 sub-groups depending upon their distance from the IR track:-

i Works being done within 3.5 meters from canter of track.

ii Works being done between 3.5 meters and 6 meters from center of track

iii Works being done beyond 6 meters from center of track

If a work site is located far away from the existing track but the vehicles in connection with the work are required to ply within the distance from center of track as mentioned above, it will be construed that the work in being executed under above classification.

c. Works being done within 3.5 meters from center of track

All works planned within 3.5 meters from center of running line or which involve working of machineries and vehicles within this zone, are to be done essentially under block protection and necessary safety precautions for protection of track as per para 806 and 807 of IRPWM shall be taken. This includes even occasional plying of vehicles/ machineries for short durations.

d. Works being done between 3.5 meters and 6 meters from center of track

Following precautions shall be taken when works are required to be done between 3.5 meters to 6 meters from track center or machines/vehicles are required to work/ply within this zone.

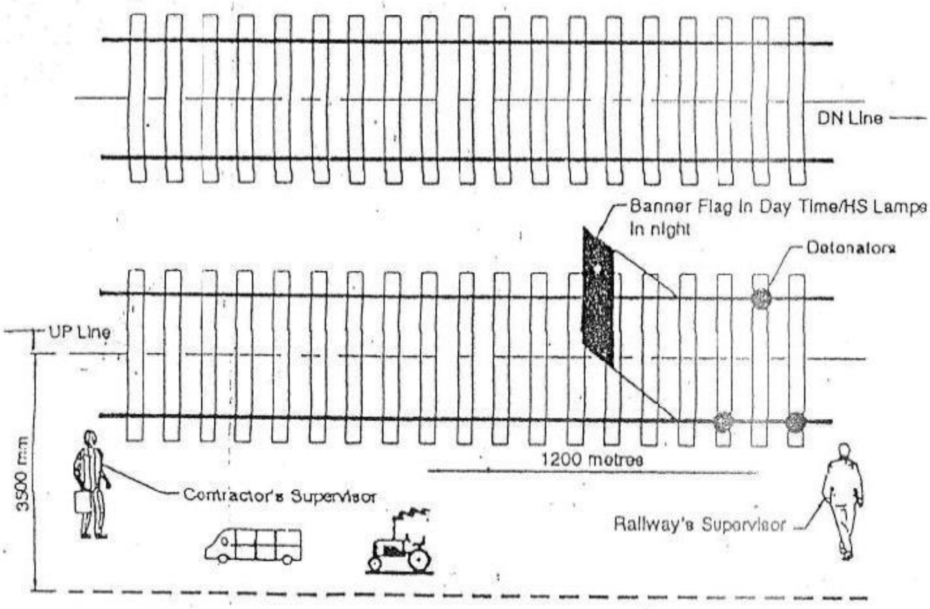
i Before start of work, demarcation should be done parallel to running track at a distance of 3.5 meters from center of track in advance, as per sketch B, by 150 mm wide white line of lime. Any work or movement of machinery infringing this line will need block protection. Barricading should be put up at such locations, as per sketch C, to ensure that even by carelessness or over sight, vehicles do not infringe fixed dimensions. Barricading design shall be approved by the Engineer.

ii In case vehicles have to ply or machineries have to work within this zone, Railway's and contractor's supervisors be positioned as shown in sketch D except mentioned in para (iii) below:

SAFTY/PROTECTION ARRANGEMENT SKETCHES

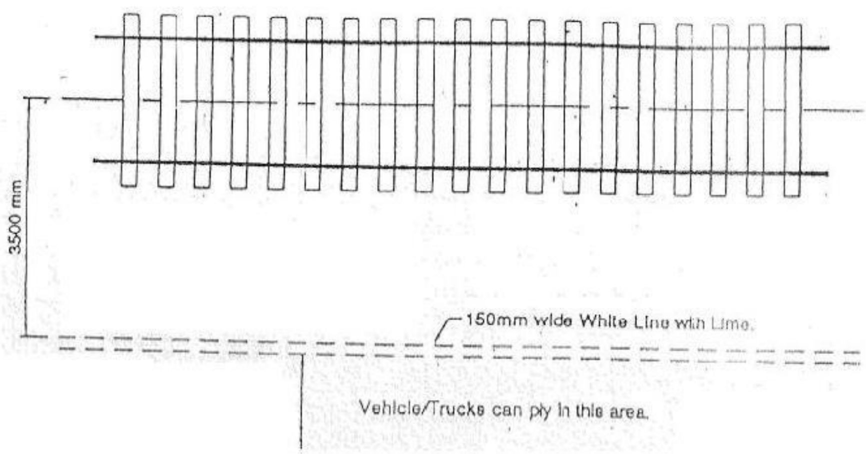
SKETCH - A

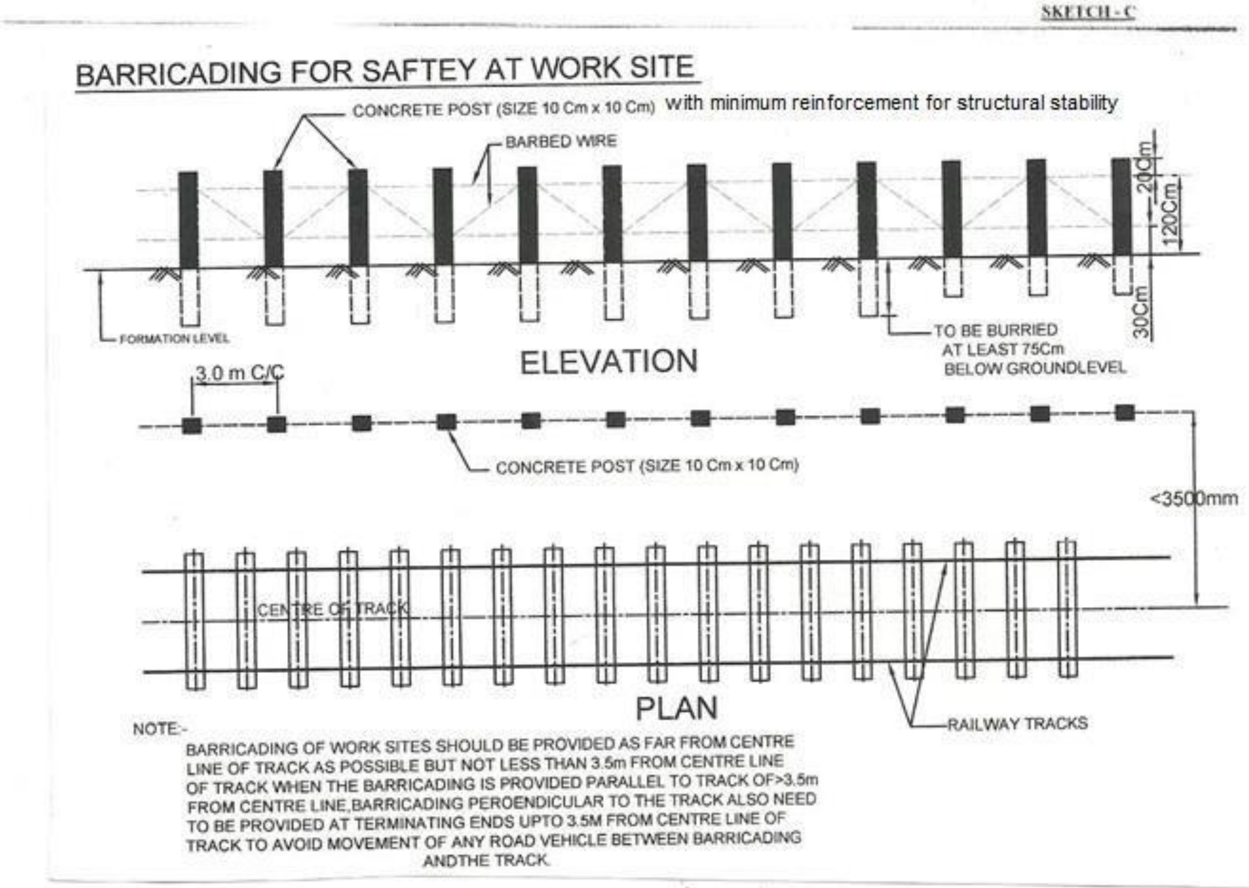
Plying of Vehicles/Machinery within 3.5 Mts. from centre of track.

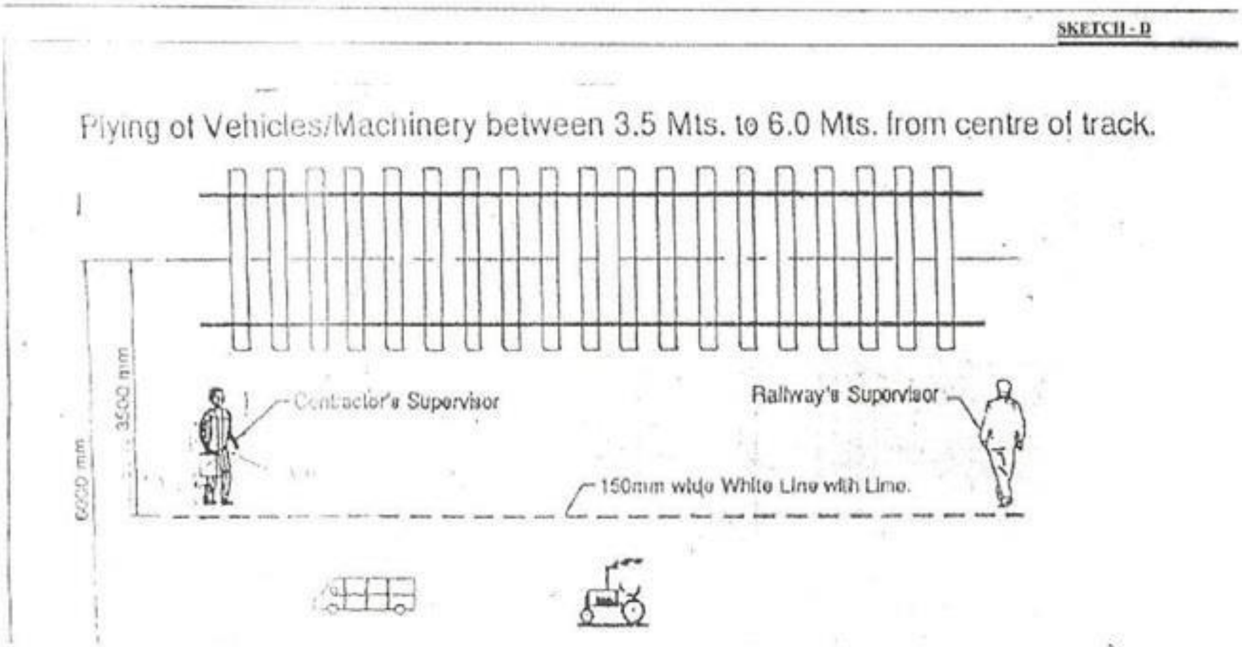


SKETCH - B

Marking of White Line with Lime.







iii. Instead of a Railway supervisor it would be a responsible and trained staff of the Contractor as mentioned in para 2.1. d), ii above.

iv. Additional trained staff of the Contractor, as mentioned in para 2.1. d), ii above, shall be posted where turning of vehicles is required during working. Location for reversing vehicles should be nominated and it should be selected in such a way that there is no danger to running trains at such a location. Such trained staff of the Contractor should be available with hand flag(s) so that vehicles do not come closer to track by 3.5 meters. Wherever vehicles have to take turn, it should be done in such a way that the driver is invariably facing the running track at all times.

v. Look out men should be posted along the track at a distance of 800 meters from location of work with red flag and to whistle in face of road vehicles and approaching trains. Look out men shall also be suitably trained staff of Contractor as mentioned in para 2.1.d), ii above.

vi. In addition to look out men, caution order needs to be issued to trains and speed restrictions imposed wherever considered necessary through Employer.

vii. Arrangements should be made to protect the track in case of emergency at work site.

viii. All temporary arrangements required during execution should be done in a manner that moving dimension is not infringed.

ix. Individual vehicle/machinery shall not be left unattended at site of work. If it is unavoidable and essential to stable it near running track, it shall be properly secured and manned even during non-working hours with all arrangements to protect the track from infringement.

x. Any material unloaded or shifted along the track should be kept clear of moving dimensions and stacked at a specified distance from running track.

xi. Movement of vehicle/working of machineries should be prohibited at night. However, in case of emergency when night working is unavoidable, adequate lighting shall be provided with all protection measures as mentioned above in full force. All night working near IR track shall require Engineer's prior approval.

xii. The work site should be suitably demarcated to keep public and passengers away. Necessary signage, boards, such as "work in progress" etc. should be provided at appropriate location to warn public/passengers.

xiii. Contractor's drivers/operators handling vehicles/machineries shall be issued a fitness certificate by the safety officer of the Contractor after educating them about safety norms and after taking assurance in writing for working within vicinity of railway's track.

xiv. While working on cuttings with machineries or when there is movement of vehicles above cutting, if there is possibility of any of the following circumstances, work has to be done under block protection:

- Any possibility exists for machinery/vehicle after toppling/due to loss of control come over track or infringe it.
- Chance of machineries/vehicles to come within 3.5 meters from track center though working beyond it.

e. Works being done beyond 6 meters from center of IR/DFCCIL track.

No precautions are needed except in cuttings or where the work can affect train running in any way.

3. CARE OF THE WORKS

3.1 General

a. Unless otherwise permitted by the Engineer, all works shall be carried out in dry conditions.

b. The Works, including material for use in the Works, shall be protected from damage due to water. Water on the Site and water entering the Site shall be promptly removed by temporary drainage or pumping system or by other methods capable of keeping the Works free of water.

c. The discharge points of the temporary drainage / pumping systems shall be as per the consent of the Engineer and shall meet all the requirements as described in Part 2, Section VII-4: HRIDC SHE Manual.

d. The methods to be used for keeping the Works free of water shall be carefully chosen so that any settlement of or damage to the Works and / or adjacent existing structures should not occur.

3.2 Protection of the Works from Weather

a. Works shall not be carried out in weather conditions that may adversely affect the Works unless proper protection is provided to the satisfaction of the Engineer.

b. Permanent Works including material for such works, shall be protected from exposures of weather conditions that may adversely affect such Permanent Works or material.

c. During construction of the Works, storm restraint systems shall be provided where appropriate. These systems shall ensure the security of the partially completed and ongoing stages of construction in all weather conditions. Such storm restraint systems shall be installed as soon as practicable and shall be compatible with the site conditions.

d. The Contractor shall at all times, program and carry out the Works duly ensuring protective arrangements such that the Works can be made safe in the event of storms.

3.3 Protection of the Finished Works

The finished Works shall be protected from theft, pilferage or any damage that could arise due to any reason. If required, sections of route may be antitheft charged at 2.2kV but only on following a strict protocol as laid down in relevant portion of ACTM and as modified for use on HORC by the Employer and after having completed all steps laid down and after Engineer's approval.

4. HANDLING OF CHARTERED / UNCHARTERED PUBLIC UTILITY

4.1.1 All chartered/ unchartered utilities including the power lines 33 kV and below with in Right Of Way (ROW) of construction/ installation shall be removed and relocated by HRIDC. The relocation/ modification of utilities pertaining to traction and transmission lines crossings above 33 kV will also be dealt by HRIDC itself.

4.1.2 In case the Engineer decides the work of removal of any unchartered utility to be done by the Contractor, this shall be treated as a Variation to the Contract and shall be dealt as per the provisions for dealing with Variations in Contract. Contractor shall be paid as per actual work done for removal of uncharted utilities based on the Variation approved by the Engineer, on case to case basis.

4.1.3 Any other public utility which interferes the Works and is required to be relocated and/or diverted and which the Contractor interprets as is not inclusive in the Contract, the Contractor shall notify the Engineer of the details of the public utility. The Employer may decide to relocate such utilities either on their own or through any other agency including the Contractor (SYS-1).

4.2 Other Interference

4.2.1 Alternative Access

Alternative access shall be availed / organized by the Contractor at his own cost through all public or private premises, when interference with the existing access occurs, to enable the Works to be carried out. The arrangements for the alternative access shall be as agreed by the Engineer and the concerned agencies. The permanent access shall be reinstated as soon as practicable after the Works are complete and the alternative access shall be removed and reinstated immediately as soon as it is no longer required. Proper signage and guidance shall be provided for the traffic / users regarding diversions.

4.2.2 Trees

Material, including excavated material, shall not be banked around trees. Trees shall be protected from damages at all times by the method(s) consented to by the Engineer. Unless otherwise consented to by the Engineer, trees shall not be trimmed or cut as stated in Part 2, Section VII-4: HRIDC SHE Manual. However, the contractor shall be required to prune the tree leaves coming in proximity of the energized OHE as per the Indian Railways Guidelines before taking over of the OHE assets by the Employer.

4.2.3 Removal of Trees, Graves and other Obstructions

Trees within ROW shall be cut by CST Contractor. If any tree, grave and other obstruction is required to be removed in order to execute the Works and such removal has not already been arranged for, the Contractor shall draw the Engineer's attention to them in good time to make necessary arrangement for such removal. The Contractor shall not itself remove them unless the Engineer has given consent.

4.2.4 Protection of the Adjacent Structures and Works

The Contractor shall take all necessary precautions to protect the structures or works being carried out by others adjacent to and, for the time being, within the Site from the effects of vibrations, undermining and any other earth movements or the diversion of water flow arising from its work.

4.3 Use Of Roads

4.3.1 General

a. Measures shall be taken to prevent the excavated material, silt or debris from entering gullies on roads and footpaths, entry of water to gullies shall not be obstructed.

b. All surfaced roads (public / private) which are chosen for construction activities in the Traffic Management Plan, shall not be used by the Contractor's tracked vehicles unless protection against damage is provided by the Contractor and / or appropriate remedial measures are prepared and agreed with the concerned parties.

4.3.2 Traffic Management Plan

The Contractor shall develop a detailed Traffic Management Plan for the Works under the Contract. The purpose is to develop a Traffic Management Plan to cope with the traffic disruption as a result of construction activities by identifying strategies for traffic management on the roads and neighborhoods impacted by the construction activities. The Contractor shall implement the Traffic Management Plan throughout the whole period of the Contract. The basis for the Plan shall take into consideration four principles:

a. to minimize the inconvenience of road users and the interruption to surface traffic through the area impacted by the construction activities;

b. to ensure the safety of road users in the impacted area;

c. to facilitate access to the Work Area, and to maintain scheduled construction progress.

d. to ensure traffic safety at each Work Area.

Wherever applicable, the Contractor shall obtain necessary approval from the transport authorities and police department for temporary traffic arrangement and control on public roads.

4.4 Reinstatement Of Public Roads And Foot Paths

a. Temporary diversions, pedestrian access and lighting, signage, guarding and traffic control equipment, if any, shall be removed immediately when these are no longer required for the construction activities.

b. Roads, footpaths and other items affected by temporary traffic arrangements and control shall be reinstated to the same condition as existed before the work started or as consented by the Engineer immediately after the relevant work is complete or at other times permitted by the Engineer.

c. Wherever required, the Contractor shall submit his plan for reinstatement to relevant authorities and obtain their prior approval to carry out the work

4.5 Security

4.5.1 The Contractor shall be responsible for the security of the Site for the full time till the issue of Taking Over Certificate except for specific cases of railway envelope after it is handed over to the Employer and / or as directed by the Engineer. The Contractor shall set up and operate a system whereby only those persons entitled to be involved in the construction activities in the Contract could enter the Work Areas. For the Site located near the populated areas, the Contractor shall, with the consent of Engineer provide the specific points only at which entry through the security fence can be effected and shall provide gate(s) and barrier(s) at such point(s) of entry and maintain security guard throughout twenty four (24) hours duration all the day. The Contractor shall also arrange for such other security personnel and patrols elsewhere as may be necessary to maintain security.

4.5.2 The Contractor shall maintain all site boundary fences, wherever provided, in good condition and shall so arrange site boundary fences and security measures that the drainage arrangement is not affected. Notices shall be displayed at intervals around the Work Areas to warn the public of the dangers of entering the Work Areas

4.5.3 During the progress of the Works, the Contractor shall maintain such additional security patrols over the Works Areas as may be necessary to protect his own and his sub-contractor's facilities and equipment as well as the Works. In addition, the Contractor shall coordinate and plan the security of both the Works under the Contract and works of the other contractors including Interfacing Parties requiring access to the Site.

4.5.4 In order to operate such a security system, it will be necessary to institute the issue of unique passes to personnel and vehicles entitled to be on the Work Areas and a system of separately identifiable according to the shifts being worked on the Work Areas. The Contractor shall, at the outset, determine together with the Engineer, a system including the design of passes to suit the requirements of the foregoing and to suit the methods of activities to be adopted by the Contractor for these purposes. The Contractor shall, at all times, ensure that the Engineer has an up to date list of all persons entitled to be on each Work Area at any time. The Contractor shall also introduce a system for issue of passes to any outsider or person/vehicles belonging to agencies other than Employer/ Engineer who may have to visit each of the Work Areas in connection with the Works.

4.5.5 The Contractor shall liaise with the other contractor(s) and the Interfacing Parties responsible for security of the adjacent areas and ensures that coordinated security procedures are operated, in particular in respect of vehicles permitted to pass through the Site and/or the adjacent sites. The security of the erected Conductors of the OHE as an antitheft charging with 2.2 kV supply shall be carried out in full liaison with other contractors.

4.5.6 Security and checking arrangements, as considered necessary shall be provided.

4.6 Contractor's Labour Camp

4.6.1 General

The Contractor shall comply with all requirements as detailed in Part 2, Section VII-4: HRIDC SHE Manual of the Bid Document.

4.6.2 Provision of Labour Camp

a. The Contractor shall, at his own expense, make adequate arrangements for the housing, supply of drinking water and provision of bathrooms, latrines and urinals, with adequate water supply for his staff and workmen at the location authorized by Engineer.

b. No labour camp shall be allowed at Site without the consent of the Engineer / Employer or any unauthorized place. The Contractor shall prepare a detailed labour camp plan to obtain the consent from the Engineer's.

c. The Contractor, at his own cost, shall maintain all camp sites clean and sanitized.

d. The Contractor shall obey all health and sanitary rules and regulations and carry out at his cost, all health and sanitary measures that may from time to time be prescribed by the Local/Medical Authorities and permit inspection of all health and sanitary arrangements at all times by the Engineer and the staff of the local municipality or other authorities concerned.

e. Should the Contractor fail to provide adequate health and sanitary arrangements, these shall be provided by the Employer and the cost thereof recovered from the Contractor.

f. The Contractor shall at his own cost, provide First Aid Stations as described in Employer's Requirement, Part 2, Section VII-1, Chapter-9 of this GS and Part 2, Section VII-4: HRIDC SHE Manual.

g. The Contractor shall at his own cost, provide the following minimum requirements for fire precautions at suitable locations complying with the requirements of applicable Codes:

   i. Portable Fire Extinguishers.

ii. Manual Fire Alarms.

iii. Water Supply for use by the Fire Service personnel.

h. The Contractor shall at his own cost provide necessary arrangements for keeping the camp area sufficiently lighted to avoid accidents to the workers.

i. The Contractor shall ensure that electrical installations are done by qualified electricians and as per the applicable Codes & Standards and these installations shall be maintained and daily maintenance records shall be available for inspection of the Engineer on demand.

j. The sites should be secured by fencing and proper lighting.

k. The construction contractor may ensure that all construction equipment and vehicle machinery may be stored at a separate place / yard.

l. Fuel storage and refilling areas may be located 500 m away from the water bodies and from other cross drainage structures.

m. All the construction workers should be provided with proper training to handle potential occupation hazards and on safety and health which include the following:-

(i) Environmental awareness program

(ii) Medical surveillance

(iii) Engineering controls, work practices and protective equipment

(iv) Handling of raw and processed material

(v) Emergency response

n. Construction / labour camps shall be located away from forest areas, settlements, cultural heritage and historical sites and water bodies and dry river beds.

o. It should be ensured by the construction contractor that the camp area is cleared of the debris and other wastes after the completion of construction. On completion of construction, the land should be restored back to its original form to the satisfaction of the Employer.

4.7 Camp Discipline

a. The Contractor shall take requisite precautions and use his best endeavors to prevent any riotous or unlawful behavior by or amongst his workmen and others, employed directly or through sub-contractors.

b. These precautions shall be for the preservation of the peace and protection of the inhabitants and security property in the neighborhood of the Works.

c. The sale of alcoholic drinks or other intoxicating drugs/ beverages in any labour camp or in any of the buildings or encampments owned or occupied by, or within the control of the Contractor or any of his employees directly or through sub-contractors employed on the work, shall be strictly prohibited and the Contractor shall ensure strict compliance.

d. The Contractor shall also ensure that no labour or employee is permitted to work at the site in an intoxicated state or under the influence of drugs.

e. The Contractor shall remove, from his camp, such labour and their families, who refuse protective inoculation and vaccination when called upon to do so by the Engineer on the advice of the Medical Authority.

f. Should Cholera, Plague or any other infectious disease breaks out, the Contractor shall, at his own cost, burn the huts, bedding, clothes and other belongings of or used by the infected parties.

g. The Contractor shall promptly erect new accommodation on healthy sites as required by the Engineer within the time specified by the Engineer, failing which the work may be done by the Employer and the cost thereof recovered from the Contractor.

h. Periodic health checkups may be conducted. These activities may be provided by the construction contractor in consultation with State Public Health Department. At every camp, first aid facilities with suitable transport must be provided as detailed in Employer's Requirement, Chapter-9 of this GS.

i. Adequate supply of fuel in the form of kerosene or LPG may be provided to construction labour, to avoid felling of trees for cooking and other household activities. No open fires may be allowed in camps.

4.8 Labour Accommodation

a. The Contractor shall provide living accommodation for all staff employed by himself or his subcontractors that is equal to or exceeds the minimum criteria established in the following sub-sections.

b. The buildings shall be constructed so as to have a minimum life of not less than the period of the Contract.

c. The roofs shall be leak-proof and laid with suitable inflammable material permissible for residential use under local regulations and for which the consent of the Engineer has been obtained.

d. Each unit shall have suitable ventilation with all doors, windows and ventilators provided with security leaves and fasteners and back to back units are to be avoided.

e. The Contractor shall provide a suitable cooking area.

f. The number of common toilet/bath/urinals shall be provided as per the provision in Section VII-4: HRIDC SHE Manual.

4.9 Water Supply

a. The Contractor shall make his own arrangements to provide adequate potable water supply in the Camp.

b. Where piped water supply is available, supply shall be at stand posts and where the supply is from wells or river, storage tanks of metal or other approved material shall be provided.

c. The Contractor shall also, at his expense, make arrangements for the provision and laying of water pipe lines from the existing mains wherever available.

4.10 Drainage

a. The Contractor shall provide efficient arrangements for draining away surface water so as to keep the camp neat and tidy.

a. Surface water shall be drained away from paths and roads and shall not be allowed to accumulate into ditches or ponds where mosquitoes can breed.

4.11 Sanitation

a. The Contractor shall make arrangements for conservancy and sanitation in the labour camps according to the rules and regulations of the Local Public Health and Medical Authorities.

b. The Contractor shall provide a sewage disposal system that is adequate for the number of residents in the camp and which meets the norms of the local authorities.

c. Provision of the latrines and wash places shall be in accordance with Part 2, Section VII-4: ocument – HRIDC SHE Manual and as per applicable Codes and Standards. However the layout shall be subject to consent by the Engineer.

d. The Contractor shall be responsible for maintaining all latrines and wash places on the Site in a clean and sanitary condition and for ensuring that they do not pose a nuisance or a health threat.

e. The Contractor shall also take such steps and make such provisions as may be necessary or as directed by the Engineer to ensure that vermin, mosquito breeding etc. are, at all times fully controlled.

(End of Appendix-5)

APPENDIX-6 - ENVIRONMENTAL PROTECTION REQUIREMENTS

1. MEASURES FOR THE MITIGATION OF ENVIRONMENTAL IMPACTS

This section describes mitigation measures to be taken in pre-construction, construction stage and defect notification stage against environmental impacts. Compliance of applicable statutory laws is essential. All applicable mitigation measures as described herein are to be adopted for land, water, air, noise, vibration and for protection of flora, fauna, health and safety issues. Monitoring and mitigation measures as elucidated in this appendix shall be the responsibility of the contractor (SYS-1), wherever applicable.

2. GENERAL

(1) Various provision mentioned in this Appendix shall be applicable for relevant works carried out by System Contractor.

(2) The Contractor shall develop its own Environment Management Plan (EMP), as a part of the Contractor's Safety Health and Environment Plan (SHE) and submit to the Engineer for approval in accordance with the relevant Government of India Legislation like Pollution Control Board, various environmental monitoring agencies of Government etc.

(3) The Contractor's detailed Designs for the Works and operations during construction shall conform to all Indian Environmental Laws and the EIA (Environmental Impact Assessment) report. .

(4) The current national standards established by the Indian Government for control of environmental pollutants such as air, water, noise and visual impacts/aesthetics shall be followed for compliance during pre-construction construction and defect notification stages.

(5) The Contractor's designs and plans shall be based upon the applicable provisions in the Environmental Management Plan of HRIDC, Environmental Impact Assessment (EIA) Report and Social Impact Assessment (SIA) Report / Resettlement Action Plan (RAP) of HRIDC.

(6) The Contractor shall ensure that proper and adequate provisions to this end are included in all sub-contracts placed by him.

(7) The provisions of this Appendix however, shall not be applicable in the case of emergency works necessary for saving of life and property or safety of the Works which shall have prior approval of Engineer in all cases.

(8) The Contractor shall undertake environmental monitoring as required under the contract, the Employer's EIA, SIA / RAP and supplement to the EIA, SIA / RAP recommendations.

(9) The Contractor shall prepare a plan for self-monitoring over the course of the project and submit to the Engineer for approval.

(10) The Contractor shall ensure that audits of all the activities detailed in his EMP are carried out at monthly intervals and reported in the Monthly Reports to ensure the continuing effectiveness and compliance with the EMP. These reports shall inter – alia cover the details as indicated in Appendix – 9 of GS.

(11) The Contractor shall make available on request any document which relates to his recent internal audits.

(12) The Engineer may conduct quarterly audits of the Contractor's EMP and its effective implementation on the works site.

(13) During the audit the Contractor shall provide a suitable number of qualified staff as directed by the Engineer to assist the Engineer during the audit.

(14) Requirements established in the EMP specifications shall apply to all sites and all activities of the Contractor, including the detailed Designs of the Systems works, and shall supplement the Employer's Requirements.

(15) In the EMP the Contractor shall appoint a suitably qualified manager responsible for the environmental as well as a support team to assist this manager. Roles and responsibilities and key communication links must be highlighted to ensure responsibility for implementing the EMP.

(16) The project may be a source of electromagnetic fields by transmission of electrical energy and the negative influences of the electromagnetic fields shall be taken into account with respect to clearances to and locations of the new Traction Sub Stations (TSS) and Over Head Transmission Lines.

(17) The Contractor shall ensure that its Environment Plan documentation includes but is not limited to the provisions covered in this Appendix.

3. ENVIRONMENTAL MANAGEMENT PROCESS

Environmental management is based on the potential impacts assessed for the project. Assessment of potential impacts is based on the review of secondary data substantiated by site visits – environmental monitoring, public consultation, household survey and discussion with concerned Govt. Dept. The implementation of Environmental Management Plan (EMP) requires the following:-

a. An organizational structure

b. Assign responsibilities

c. Define timing of implementation

d. Define monitoring responsibilities

4. EMP DURING CONSTRUCTION

The project activities shall be executed in a phased manner, pre-construction phase, construction phase and operation phase. The major activities to be undertaken during construction phase are described below.

The environmental issues during construction phase generally involve quality, safety and public health issues. The Contractor is required to comply with the laws with respect to environment protection, pollution control, forest conservation, safety and any other applicable laws. Environmental pollution control during the construction phase shall be the responsibility of the Contractor. EMP is an executable part of project and the activities are to be guided, controlled, monitored and managed as per the provisions provided.

5. SOCIAL IMPACT MANAGEMENT PLAN (BY HRIDC)

HRIDC is responsible for implementation of Social Impact Management & Resettlement Action Plan (RAP). Rehabilitation of PAFs and removal of affected structures shall be responsibility of HRIDC.

6. LAND ACQUISITION / DIVERSION PLAN

By HRIDC: Acquisition of land is the responsibility of HRIDC.

a. At the outset Right of Way (RoW) along the entire HORC alignment has been established and confirmed from the State Forest, Agriculture and Land Revenue Departments.

b. Diversion of forest land is ensured for the project by HRIDC in compliance to Forest Conservation Act, 1980.

c. The acquisition of land and private property shall be carried out in accordance to the Resettlement Action Plan (RAP).

By Contractor: Where temporary land is acquired by the Contractor for setting up labour camp, placing of construction related equipment, dumping of wastes, stacking of excavated earth, etc., the Contractor shall be responsible for such land acquisition/ hiring from the rightful owners following applicable procedures / rules, compensation / rent thereof and implementation of EMP provisions for the same.

7. AVOIDANCE OF NUISANCE

(1) The Contractor shall take all precautions to avoid any nuisance arising from his operations. This shall be accomplished, wherever possible by suppression of nuisance at source rather than abatement of the nuisance once generated.

(2) The Contractor shall ensure that the work place is free of trash, garbage, debris and weeds. He shall provide and ensure proper uses of refuse containers to ensure that rodents, insects and other pests are not harbored and attracted.

(3) The Contractor shall provide a dedicated team of workers at each work site who shall be solely employed to keep the site and its surroundings in a clean condition and maintain a good standard of house-keeping on the site.

(4) All vehicles leaving the site shall have their wheels washed to prevent any soil or other material from contaminating the public roads.

(5) The Contractor shall promptly transport all excavation disposal material of whatever kind so as not to delay work on the project. Stockpiling of material shall only be allowed at sites designated by the Engineer.

(6) The Contractor shall protect structures, utilities, pavements and other facilities from disfiguration and damage.

(7) The Contractor's temporary dumping areas shall be maintained by the Contractor till the material are re-utilized for back-filling or any other purpose as per instructions of Engineer.

8. CONSTRUCTION / LABOUR CAMP MANAGEMENT

During the construction phase, proper construction camp development plan has to be formulated to control degradation of the surrounding landscape due to the location of the proposed construction camp. The Contractor must provide, construct and maintain necessary living condition and ancillary facilities as detailed in Appendix - 5.

9. MITIGATION MEASURES OF LAND ENVIRONMENT DURING CONSTRUCTION

While HRIDC is responsible for land acquisition, the Contractor shall be responsible for use of the land during construction. Hence, the Contractor shall take necessary measures as enumerated in the EMP to prevent/ arrest soil erosion, contamination.

Land acquisition, soil erosion and contamination of soil have emerged as major sources of impact on the land especially in urban areas and nearby watercourses. Proposed project aimed to enhance the efficiency of rail transport system, which shall result in economic growth in the region over time. Possible impacts on land are given below:

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1.	Change in geology	Direct, long term, negative impact	Extraction of material (borrow earth, coarse & fine aggregates)	Quarry redevelopment plan to be prepared. (If material is procured from a private quarry then Contractor is required to arrange and submit such a plan from the quarry owner.
2.	Change in seismology	No negative impact	Natural process	Cross drainage structures shall be checked and complied with the seismological settings of the region as per the applicable Design codes.
3.	Change in land environment	Direct negative impact	May be due to construction activities	Preventive measures against pollution of land/ soil to be taken
a.	Generation of debris	Negative impact	May contaminate air, water and land, if not disposed properly	Disposed properly to avoid contamination
b.	Soil erosion	Moderate, direct, long term negative impact	• Slopes and spoils near the bridges • Construction of new bridges and culverts	• Embankment protection • Residual spoil need to be disposed properly • silt fencing need to be provided,
Sl. No.	**Item**	**Impact**	**Impact (Reason)**	**Mitigation / Enhancement**

			• quarry and burrow areas	• Quarries and burrow areas shall have necessary consents / approvals from authorities. All quarries and borrow areas closed after the project shall be reclaimed. In case of quarries not being operated by Contractor shall submit such approvals or consents from the quarry owner.
4.	Contamination of soil	Direct, long term negative impact	• Scarified bitumen wastes • Oil & diesel spills • Emulsion sprayer and lying of hot mix • Production of hot mix and rejected material • Residential facilities for the labor and officers requiring routine and periodical maintenance	• Hazardous Waste (Management, Handling and Trans-boundary) Rules, 2008 to be enforced. • Oil interceptor shall be provided for accidental spill of oil and diesel • Septic tank or suitable waste disposal facilities shall be constructed for waste disposal
5.	Soil quality monitoring		• Effectiveness / shortfall (if any) • Any unforeseen impact	Measures shall be reviewed & improved to mitigate / enhance environment due to any unforeseen impacts

10. BORROW AREA MANAGEMENT PLAN

a. Borrow areas shall be identified and finalized by the Contractor in consultation with Engineer. Formal agreement between landowners and the Contractor has to be made. Suitability of burrow areas from civil Engineering as well as environmental consideration has to be ensured. Meeting the guidelines/notifications as stipulated from time to time by the Ministry of Environment and Forests, Government of India, and local bodies, as applicable shall be the sole responsibility of the Contractor.

b. Besides this, precautions are to be taken by the Contractor for no unauthorized borrowing. No borrow area shall be opened without permission of the Engineer. Engineer in addition to the established practices, rules and regulation shall also consider under-mentioned criteria before approving the Borrow areas.

c. To avoid any embankment slippage, the borrow areas shall not be dug continuously and the size and shape of borrow pits shall be decided by the Engineer. Redevelopment of the borrow areas to mitigate the impacts shall be the responsibility of the Contractor. The Contractor shall evolve site-specific redevelopment plans for each borrows area location, which shall be implemented after the approval of the Engineer.

d. To ensure that the spills, which might result from the transport of borrow and quarry material do not impact the settlements, it shall be ensured that the excavation and carrying of earth shall be done in a careful manner. The unpaved surfaces used for the haulage of borrow material shall be maintained properly. Borrowing of earth shall be carried out at locations recommended as follows:

e. Non-Cultivable Lands: Borrowing of earth shall be carried out up to a depth of 2 m from the existing ground level.

f. Borrowing of earth shall not be done continuously. Ridges of not less than 8m width shall be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges, if necessary, to facilitate drainage. Borrow pits shall have slopes not steeper than 1 vertical in 4 horizontal.

g. Productive Lands: Borrowing of earth shall be avoided on productive lands. However, in the event of borrowing from productive lands, under circumstances as described above, topsoil shall be preserved in stockpiles. The conservation of topsoil shall be carried out as described in section of this Appendix. At such locations, the depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside.

h. Elevated Lands: At locations where private owners desire their fields to be leveled, the borrowing shall be done to a depth of not more than 2 m or up to the level of surrounding fields.

i. Burrow pits along Roadside: Burrow pits shall be located 5m away from the toe of the embankment. Depth of the pit should be such that the bottom of the pit shall not fall within an imaginary line of slope 1 vertical to 4 horizontal projected from the edge of the final section of the bank. Burrow pits should not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains should be cut through the ridges to facilitate drainage.

j. Burrow pits on the riverside: The burrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood.

k. Community / Private Ponds: Borrowing can be carried out at locations, where the private owners (or in some cases, the community) desire to develop lands (mostly low-lying areas) for pisciculture purposes and for use as fishponds.

l. General: - Contractor shall ensure the following issues are covered to the satisfaction of Engineer.

   i. Water pooling to be avoided/ managed so that no disease spread or mosquito breeding takes place due to water stagnation.

   ii. Precautionary measures as the covering of vehicles may be taken to avoid spillage during transportation of borrow area.

   iii. Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction facility is operating at the place of deposition, to minimize dust pollution.

iv. During rains appropriate measures to be taken to minimize soil erosion, silt fencing to be provided as directed by Engineer/ EO.

v. Burrow pit should have proper guard to prevent accidental falling of children or animals.

m. The Contractor shall keep record of photographs of various stages i.e., before using material from the location (pre-project), for the period borrowing activities construction Phase) and after rehabilitation (post development), to ascertain the pre and post borrowing status of the area.

n. An appropriate Borrow Area Management Plan shall be formulated to control the degradation of the surrounding landscape due to the excavation work. The national standard which applies to the manual borrowing of earth is detailed in IRC-10:1961.

11. MITIGATION MEASURES TO MINIMIZE SOIL EROSION DURING CONSTRUCTION

(1) Suitable protection measures consisting of bio-Engineering techniques such as plantation of grass and shrubs, may be provided to control erosion. The measures shall be applied along the slopes at high embankment where bridges shall be constructed.

(2) Borrow areas may be finalized in concern with ecological sensitivity of the area. Agriculture land may not be used as borrow areas. Priority may be given to degraded area for excavation of borrows material. Rehabilitation of borrow area may be taken under the project.

(3) Construction work may be avoided during rainy season to evade erosion and spreading of loose material.

(4) Top soil removed from agricultural land may be stored separately in bunded areas and utilized during plantation or refilling of excavated area.

(5) Selection of borrow areas may be done considering the waste land available in the district. Agricultural areas may be not used as borrow areas.

12. GEO-TECHNICAL ISSUES

The Contractor shall submit within the EMP the expected construction impacts for all major facilities and sections of higher embankments and deeper excavations, including material used for the building of the formation prior to construction, these impacts should include:

(1) Determination of formation material quality and placement impact;

(2) Stability factors, including seismic migration;

(3) Drainage facilities for groundwater dewatering;

(4) Effects on the local communities and transportation networks from overland truck transport of fill and excavate to and from the specific borrow and fill sites.

(5) Specific mitigation measures and maintenance-of-traffic plans to ensure minimal

disruption on local traffic conditions and the environment.

13. MITIGATION MEASURES FOR AMBIENT AIR QUALITY

(1) Pre-Construction / preparatory Phase: The dust generation due to pre-construction activities shall be temporary in nature and localized and shall be effectively countered by sprinkling of water wherever required.

(2) Construction Phase: Contractor shall undertake following specific measures regarding this aspect:-:

a. Locating plant at a significant distance from nearest human settlement in the predominant down wind direction.

b. Vehicles delivering fine material like soil and fine aggregates may be covered to reduce spills on existing roads.

c. Water shall be sprayed on earthworks, temporary haulage and diversions on a regular basis.

d. Batch type hot mix plants fitted with the bag filter / cyclone and scrubber shall be installed for the reduction of the air pollution.

e. Hot mix plant and crushers shall be located at least 1 km from habitations and in down wind direction.

f. Pollution control systems like water sprinkling and dust extractors and cover on conveyors shall be installed for the crushers.

g. All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that the emission levels conform to the SPCB/CPCB norms.

h. Air pollution monitoring plan has been delineated for construction phase separately for checking the effectiveness of the mitigation measures shall be adopted during the construction phase of the Contract

i. Air quality monitoring shall be conducted during construction period and CPCB standard should be followed. The location and frequency of air monitoring is covered in EA document referred.

14. MITIGATION MEASURES FOR WATER QUALITY

Due to the proposed project there shall be some direct and indirect long term impacts on the water resources during construction. Table below presents the major adverse impacts on the water resources and the mitigation measures taken. While planning for mitigation measures is the responsibility of the HRIDC, the Contractor shall be responsible for execution of the same.

Sl. No.	Item	Impact	Impact (Reason)	Mitigation/Enhancement
1.	Loss of water bodies	Not significant as no major water bodies is fully affected	Part or acquisition of source of water	• Land will be acquired by H R I D C for ROW • Relocation of surface water sources by HRIDC

Sl. No.	Item	Impact	Impact (Reason)	Mitigation/Enhancement
2.	Water requirement for construction work (to be organized by Contractor)	Direct impact	• Water requirement for construction activity. • Water requirement of labour	Contractor needs to obtain approval for taking adequate quantities of water from surface and ground water sources from applicable competent authority.
3.	Water Quality			
a.	Increased sedimentation	Direct impact	• Increased sediment laden run-off alter the nature & capacity of the watercourse	Guidelines for sediment control shall be followed
b.	Contamination of water	Direct adverse impact	• Scarified bitumen wastes • Oil & diesel spills • Emulsion sprayer and laying of hot mix • Production of hot mix and rejected material • Residential facilities for the labour and officers • Routine and periodical maintenance	• Hazardous Wastes (Management, Handling and Trans-boundary) Rules, 2008 to be enforced • Oil interceptor shall be provided for accidental spill of oil and diesel by Engineer • Septic tank or suitable disposal arrangements shall be provided for waste disposal
b.	Contamination of water	Direct adverse impact	• Scarified bitumen wastes • Oil & diesel spills • Emulsion sprayer and laying of hot mix • Production of hot mix and rejected material • Residential facilities for the labour and officers • Routine and periodical maintenance	• Hazardous Wastes (Management, Handling and Trans-boundary) Rules, 2008 to be enforced • Oil interceptor shall be provided for accidental spill of oil and diesel by Engineer • Septic tank or suitable disposal arrangements shall be provided for waste disposal
4.	Water quality monitoring	Data to be monitored w.r.t. statutory norms	• Effectiveness / shortfall (if any) • Any unforeseen impact	Measures shall be reviewed & improved to mitigate / enhance environment due to any unforeseen impact

a. Water Quality Management

Contractor shall undertake following measures to avoid contamination of water bodies:-.

i. Construction work close to the streams or water bodies may be avoided during monsoon.

ii. The discharge standards promulgated under the Environmental Protection Act, 1986 shall be strictly adhered to. All wastes arising from the project shall be disposed of in a manner that is as per the provisions of the State Pollution Control Board (SPCB).

iii. Unless otherwise authorized by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the workplace suitably approved by the local medical health or municipal authorities shall be made.

iv. Water quality shall be monitored regularly near the construction site.

15. NOISE ENVIRONMENT – MITIGATION MEASURES

Following mitigation measures will be implemented by the Contractor.

Sl. No.	Item	Impact	Impact (Reason)	Mitigation / Enhancement
1	Noise pollution (pre-construction)	Direct impact, short duration	• Man, material and machinery movements • Establishment of labor camps onsite offices, stock yards and construction plants	• Area specific and for short duration • Machinery to be checked & complied with noise pollution regulations. • Camps to be setup away from the settlements.
2	Noise Pollution (Construction Stage)	Marginal impact	• Stone crushing, asphalt production plant and batching plants, diesel generators etc. • Community residing near to the work zones	• Camps to be setup away from the settlements, in the down wind direction. • Noise pollution regulation to be monitored and enforced. • Temporary, as the work zone will be changing with completion of construction
3	Noise Pollution Monitoring (Construction stage)	Data to be monitored w.r.t. statutory norms	Effectiveness / shortfall (if any) Any unforeseen impact	Measures will be reviewed & improved to mitigate/ enhance environment due to any unforeseen impact.

16. MITIGATION MEASURES FOR NOISE DURING CONSTRUCTION PHASE

(1) Noise standards shall be strictly enforced on all vehicles, plants, equipment, and construction machinery. All construction equipment used for an 8-hour shift shall conform to a standard of less than 90dB (A). If required, high noise producing generators such as concrete mixers, generators, graders, etc. shall be provided with noise shields/ mufflers.

(2) Machinery and vehicles shall be maintained regularly, with particular attention to silencers and mufflers, to keep construction noise levels to minimum.

(3) Workers in the vicinity of high noise levels shall be provided earplugs/ ear mufflers helmets and shall be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90dB(A) per 8 hour shift. CPCB standard is to be observed.

(4) During construction vibratory compactors will be used with due care within the urban areas. In case of complaints from nearby residents, the Engineer shall ask

the Contractor to take suitable steps of restricting the work hours even further or use an alternative roller.

(5) Proposed tree and shrub plantations planned for avenue plantation especially close to settlements, may form an effective sound buffer during the operation stage.

(6) People have to be convinced / educated to prevent sensitive land uses from developing up adjacent to the project corridors.

17. CONTROL REQUIREMENTS

Under the Contract, the Contractor shall:

(1) Perform work within the procedures outlined herein and comply with applicable codes, regulations, and standards established by the Indian Government and their agencies.

(2) Schedule and conduct operations in a manner that shall minimize, to the greatest extent feasible, the disturbance to the public in areas adjacent to the construction activities and to occupants of buildings in the vicinity of the construction activities.

(3) Submit to the Engineer a Noise Monitoring and Control Plan (NMCP), within 4 months from Commencement Date, which shall form part of the overall EMP, including full and comprehensive details of all powered mechanical equipment, which he proposes to use during daytime and night-time and of his proposed working methods and noise level reduction measures.

(4) The NMCP shall include detailed noise calculations to demonstrate the anticipated noise generation by the Contractor.

(5) The NMCP prepared by the Contractor shall guide the implementation of construction activity.

(6) The NMCP will be reviewed on a regular basis and updated as necessary to ensure that current construction activities are addressed.

(7) It shall appear as a regular agenda item in project coordination meetings.

18. MITIGATION MEASURES FOR HYDROLOGICAL CONDITION (RIVERS AND LAKES)

Construction Phase

a. To avoid any unwanted accumulation of water/ water logging, provision of temporary drainage arrangement due to construction activities shall be made by Contractor.

b. Silt fencing may be provided near water bodies.

c. Proper drainage may be planned in the area to avoid water logging.

19. MITIGATION MEASURES FOR FLORA DURING CONSTRUCTION

(1) Land free from encumbrances including trees and structures shall be provided to the contractor by HRIDC. Cutting / removal of trees shall be done by CST contractor and permission/NOC shall be the responsibility of HRIDC. For temporary land / site hired/ acquired by the Contractor cutting of trees will be the responsibility of the Contractor.

(2) Trees falling outside the ROW shall not be felled.

(3) Labour camps and office site shall be located outside and away from the forest area.

20. MITIGATION MEASURES FOR FAUNA DURING CONSTRUCTION

(1) Borrow areas can be also developed as ponds with grasses and shrubs planted around it.

(2) Silt fencing may be used near water bodies to avoid runoff into the water bodies.

(3) Construction activity may be avoided during night hours in forest area.

(4) Poaching must be strictly banned in the forest area. It may be ensured by the Contractor that no hunting or fishing is practiced at the site by any of the worker and that all site personnel are aware of the location, value and sensitivity of the wildlife resources. The Wildlife (Protection) Act, 1972 will be applicable.

(5) Awareness program on Environment and Wildlife Conservation may be provided to the work force. Forest Act and Wildlife Act may be strictly adhered to.

21. LANDSCAPE

Construction Phase

Landscaping plan may be formulated for restoration, leveling and landscaping of the area once construction activities are over. This can involve the following:-

(1) The stockpiles may be designed such that the slope does not exceed 1:2 (vertical to horizontal) and the height of the pile to be restricted to 2 m.

(2) Stockpiled topsoil may be used to cover the disturbed areas and cut slopes. The top soil shall be utilized for redevelopment of borrow areas, landscaping along slopes, incidental spaces etc.

(3) Incorporation of suitable and effective contractual clauses for rehabilitation and restoration of borrow areas and other temporary works and landscaping it with surrounding area immediately after its use shall be made by the Contractor with its Sub Contractor for earthworks.

22. VIBRATION LEVEL LIMIT

(1) The vibration level limits adjacent to the alignment shall conform to appropriate legislation of Government of India in this regard. In absence of any Indian standard, relevant international standards may be referred.

(2) The scheme for monitoring the vibration level at the site shall be submitted to Engineer for his approval.

(3) The scheme shall include:

a. monitoring requirements for vibrations at regular intervals throughout the construction period;

b. pre-construction structural integrity inspections of historic and sensitive structures close to project activity is to be conducted by the Contractor in consultation with Engineer;

c. Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.

23. ARCHAEOLOGICAL STRUCTURE

Any structure/ article of archaeological importance found during construction stage along the alignment, shall be dealt as per the Act and procedure detailed in Environmental Management Framework.

24. PUBLIC HEALTH AND SAFETY

The Contractor is required to comply with all the precautions required for the safety of the workmen. The Contractor must comply with all regulation regarding scaffolding, ladders, working platform, excavation, etc. as per SHE manual of HRIDC. Silica Exposure Reduction Strategies to be implemented by the Contractor during construction is given at Annexure-I attached with this Appendix.

25. GREEN BELT

Green belt as and if required, shall be developed by CST contractor within the land acquired by the HRIDC for the project. Hence, development of green belt is not included in the scope of System Contract. System contractor shall ensure not to damage any green belt. In case of any damage to the green belt during course of work, the contractor shall make good the damage in consultation with the Engineer.

26. WASTE

A. **Control of waste generation during construction and its safe disposal is the responsibility of the Contractor**.

(1) Principle of 3R's (Reduce, Reuse, Recycle) shall be followed while handling waste from the construction Site. The Contractor is required to develop, institute and maintain a Waste Management Program (WMP) during the construction of the project for his works, which may include:-

a. Identification of disposal sites.

b. Identification of quantities to be excavated and disposed of.

c. Identification of split between waste and inert material

d. Identification of amounts intended to be stored temporarily on site location of such storage.

e. Identification of intended transport means and route.

f. Obtaining permission, wherever required, for disposal.

(2) A mechanism shall be developed to ensure that the pre-designated area is available for the segregation and temporary storage of reusable and recyclable material. This shall be incorporated in the WMP. The WMP should be prepared and submitted to the Engineer for approval.

(3) The Contractor shall handle waste in a manner that ensures that wastes are held securely, maintained and waste storage area is cleaned regularly.

(4) The Contractor shall remove waste at regular interval and dispose at landfill sites, if available nearby, after obtaining approval/ consent of concerned authority. If such authority or landfill site is not available nearby, the wastes

may be dumped at a pre-designated site within Project area in consultation with SPCB & Engineer.

(5) Burning of wastes is prohibited. The Contractor shall not burn debris or vegetation or construction waste on the site but remove as per relevant Rules.

(6) The Contractor shall make arrangements to disposal off metal scrap and other wastes which can be sold to authorized dealer(s) and maintain record of such sale for inspection by the Engineer.

B. Hazardous Waste Management (By Contractor)

(1) Any waste classified as hazardous under the "Hazardous Wastes (Management, Handling and Trans boundary) Rules, 2008, shall be disposed according to the concerned Rules.

(2) Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 shall be stored in compliance with the said Rules.

(3) The Contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file a "Request for Authorization" to SPCB along with a map showing the location of storage area.

(4) Outside the storage area, the Contractor shall place a display board clearly mentioning 'Hazardous Wastes' and quantity and nature of wastes, on date. Hazardous Waste needs to be stored in secured manner.

(5) It shall be the responsibility of the Contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors.

(6) The Contractor shall approach only registered & authorized Recyclers of Hazardous Waste for direct sale/ disposal of Hazardous Waste, under intimation to SPCB.

27. ENVIRONMENTAL MANAGEMENT PLAN & RESPONSIBILITIES

Table below presents summary of Environmental Management Plan (EMP) with the objective to minimize adverse environmental impacts during pre and during construction activities. The table covers possible environmental issues involved in the project and the corresponding necessary mitigation measures. Taking appropriate mitigation measures for the construction phase shall be the responsibility of the Contractor, and of the construction projects' Environmental Engineer who shall supervise the implementation of the EMP.

The System Contractor shall implement EMP during pre and during construction phases while mitigation measures during the operation phase shall be implemented by the

HRIDC. The details of Environmental Management Program and Environmental Management Unit (EMU) are discussed in the subsequent paragraphs.

S. No.	Environmental Issue	Action to be Taken	Supervision By

Pre-Construction Phase			
1.	Removal of Trees	Trees are likely to be felled in the Temporary land acquired by the contractor for labour camp etc. after obtaining permission from the concerned authorities.	HRIDC through Engineer or other nominated agencies.
Construction Phase			
1.	Soil	Suitable protection measures to be provided to control erosion. Borrow areas to be finalized as per instruction of Engineer. Agriculture land shall be avoided as a borrow area. Priority may be given to degraded area for excavation of borrow material. Rehabilitation of borrow area to be taken up. Construction work may be avoided during rainy season to avoid erosion and spreading of loose material. Top soil removed from agricultural land shall be stored separately in protected area for utilization during plantation or refilling of excavated area.	HRIDC through Engineer or other nominated agencies
2.	Water Bodies	Provision of temporary drainage arrangement due to construction activities may be made by Contractor. Silt fencing may be provided near water bodies. Proper drainage may be planned in the area to avoid water logging.	HRIDC through Engineer or other nominated agencies
3.	Flora	Felling of trees for temporary land acquired by the contractor to be undertaken in coordination with Engineer and after obtaining permission of Forest dept. Trees outside the ROW shall not be felled. Labour Camps and office site shall be located outside & away from Forest area.	HRIDC through Engineer or other nominated agencies
4.	Fauna	Ponds may be developed inside forest areas as the birds prefer water bodies. Borrow areas may be considered for the purpose. Silt fencing may be used near water bodies to avoid runoff into the water bodies. Construction activity may be avoided during night hours in forest area. Poaching is strictly banned in the Forest area as per relevant Act. The Contractor and its personnel shall be follow the same.	HRIDC through Engineer or other nominated agencies

S. No.	Environmental Issue	Action to be Taken	Supervision By
5.	Chance find :Archaeological structure/ article	Al structures/articles found during construction stage along the alignment, shall be dealt as per relevant Act and procedures. The contractor shall obtain No Objection Certificate from ASI observing the following : 1. Necessary arrangements will be made to install appropriate equipment at the protected monument to monitor whether there is any structural threat on account of the railway operations. 2. Necessary measures may be put in place for proper drainage along the raised embankment which will have the railway track. 3. Cultural sign boards may be placed near the protected monuments to highlight its importance etc.	HRIDC through Engineer or other nominated agencies
Pollution monitoring			
1.	Air	Adequate dust suppression measures to be undertaken to control fugitive dust. Plantation activity to be undertaken at the construction sites. Workers to be provided with mask to prevent breathing problems while working with dust generating machine/ earth excavation / filling process. Trucks carrying soil, sand and stone may be covered to avoid spilling. Low emission construction equipment, vehicles and generator sets shall be used Plants, machinery and equipment should be handled in a manner to minimize dust generation. All crushers used in construction shall confirm to relevant standards. Air quality monitoring to be conducted at construction sites periodically.	HRIDC through Engineer or other nominated agencies / SPCB
2.	Water	Silt fencing shall provide near water bodies to avoid spillage of construction material. Discharge of waste from construction / labour camp into water bodies without treatment is strictly prohibited. Construction methodologies with minimum or no impact on water quality to be adopted. Construction debris /wastes to be disposed at designated sites	HRIDC through Engineer or other nominated agencies / SPCB
3.	Soil	Asphalt emulsifier shall be handled with caution and any leakage detected shall be immediately rectified. Construction work may be avoided during rainy season to avoid erosion and spreading of loose material	HRIDC through Engineer or other nominated agencies

S. No.	Environmental Issue	Action to be Taken	Supervision By
4.	Solid Waste	Construction work shall be carried in such a way that minimum or no solid waste is generated at construction site. Extra earth material produced may be utilized for refilling of borrow areas. Rainy season may be avoided to minimize spreading of loose material. Solid waste management plan may be framed for implementation in camp areas. Dustbins to be provided in the Camps. Proper sanitation facilities must be provided in Camp by the Contractor.	HRIDC through Engineer or other nominated agencies / SPCB
5.	Noise & Vibration	Noise from construction machines to be minimized by selection of right machine and noise suppressor wherever possible. Construction equipment's and vehicles shall be in good working condition, properly lubricated and maintained to keep noise within permissible limits. Temporary noise barriers to be installed at settlements and forest area, if required Plantation may be carried at the work site. Head phones, ear plugs to be provided to the workers working with high noise generating equipment at construction site. Noise level monitoring shall be conducted during construction phase. All vehicles, equipment and machinery used in construction shall be fitted with exhaust silencers.	HRIDC through Engineer or other nominated agencies / SPCB
6.	Land Subsidence	Plantation shall be done to control erosion at specific areas.	HRIDC through Engineer or other nominated agencies
7.	Bottom Sediment	Silt fencing may be provided to avoid runoff into the river. Construction activity may be taken in dry season to avoid spreading of construction material and minimize impact on water quality	HRIDC through Engineer or other nominated agencies

28. ENVIRONMENTAL MONITORING

The environmental monitoring shall be undertaken during construction and operation phases as per the details given the Table below. The System Contractor shall **survey, assess the requirements and comply the regulations/ standards**. While the

Contractor will be responsible for monitoring of environmental components during construction and necessary mitigation measures, HRIDC will be responsible during operation phase.

Construction Phase

S. No.	Environmental Component	Parameter	Standards	Location	Frequency	Supervision
1	Air Quality	SPM, RPM, CO, NOx, Sox	CPCB standards	Stretch of the Project in progress near settlements and junctions stations.	3 times in a year (once in every season except monsoon)	HRIDC through Engineer or other nominated agencies
2	Water Quality	As per IS:10500 standards		Near water bodies and construction camps along the Project.	Once in three months during construction period, excluding Monsoon	
3	Noise	Noise level on dB (A) scale		Junction & stations and settlements along the Project.	4 times in a year (once in every season)	
4	Soil Quality	NPK, Sodium Absorption Ratio, Oil & Grease		Junction & stations and settlements along the Project.	Once in a year	

Annexure – I

SILICA EXPOSURE REDUCTION STRATEGIES (BY CONTRACTOR DURING CONSTRUCTION)

A. GENERAL APPLICATION

i. Description

a) This addendum specifies minimum environmental health and safety equipment, practices and procedures to minimize exposures to airborne silica dust during quarry operations, stone crushing, transport, and site construction. The scope of this section is limited to dust controls and employee protection in these environments.

b) This addendum shall take precedence over overlapping requirements in the Technical Specifications unless otherwise stated.

c) This document is an integral part of the contract and the contractor has the responsibility to fully implement it. Any request to deviate from any specified requirement shall be made in writing to the project sponsor.

d) This addendum supplements all local, regional and national laws and regulations concerning the location, environmental emissions, and occupational safety in these operations. If regulatory requirements are more stringent, or require more frequent verification than outlined in this standard, then the regulatory provisions shall take precedence and become the de facto requirement in that jurisdiction.

e) Contractor(s) shall provide a copy of the licensing documentation (NOC/ Consent to Establish) for each facility from where they purchase crushed stone including each quarry, stone crusher mill, and hot mix plant indicating they meet all applicable requirements.

ii. General Site Requirements Quarries

a) Operator must establish a reliable source of water with adequate capacity and pressure to run all dust suppression systems at the quarry site;

b) Operator must establish a reliable source of power for all mechanical equipment at the stone quarry site;

c) Residential areas and temporary employee housing must be located a minimum of 100 meters from any quarrying operations;

d) Stone drilling, cutting and conveying operations shall be equipped with either continuous wet suppression system or dry dust collectors designed and operated per minimum requirements below.

e) Dust controls in quarries must include water fed compressed air drilling equipment, enclosed screens; enclosed transfer points, covered conveyors, and chutes.

f) Wet the surface of rock material with a hose before blasting operations.

iii. General Site Requirements Stone Crusher Mills and Hot Mix Plants

1) Contractor shall submit a detailed plan for any temporary stone crusher or hot mix plant sites intended to be utilized for this project. The plan shall show adjacent areas within 100 meters and depict all structures and roadways. All temporary sites must meet all requirements specified in this addendum and must obtain a Consent to Establish/ (NOC) from the applicable authorities.

1) Temporary or permanent stone crusher sites or hot mix plants must meet all of the following requirements:

a) Site must be at least 250 meters from National and State Highways and 500 meters from schools, educational institutions and religious places.

b) Establish green belt zone as required by applicable local requirements;

c) Residential areas and temporary employee housing must be located a minimum of 200 meters from any stone crushing equipment or operations;

d) Operator must establish a reliable source of water with adequate capacity and pressure to run all dust suppression systems installed at the stone crusher site;

e) Operator must establish a reliable source of electricity for powering all mechanical equipment and pollution controls installed at the stone crusher site;

f) Crushing, screening, and conveying operations shall be equipped with either continuous wet suppression system or dry dust collectors designed and operated per minimum requirements below.

g) Crushing, screening, and conveying operations must be enclosed with sheet metal or other rigid material. Do not use cloth or plastic enclosures.

h) Roadways inside the crusher mill shall be metalled, paved or otherwise treated with chemical suppressants for dust suppression.

i) Waste dust material from stone crushing operations shall be stored in closed containers or closed structures.

j) Lorries exiting the site must be cleaned with shovel and broom to minimize dust being tracked off site.

k) Minimize drop heights to storage piles;

l) Windbreak walls that are at least six times longer than its height shall be in place.

m) Regularly remove and safely dispose of waste material (rock dust) from the plant site in covered lorries;

n) Fugitive emissions including emissions from stockpiles, conveyors and other areas shall be minimized as far as practicable. Emissions from these sources shall be substantially free from visible dust emission

B. GENERAL SITE REQUIREMENTS CONSTRUCTION SITES

The following requirements shall be implemented during the following operations:

i. Stockpiling;

ii. Earth moving/ earth works, grading, and leveling;

iii. Transfer from stock pile to work site;

iv. Final placement; and

v. Laying the track.

a) Operator must establish a reliable source of water with adequate capacity and for all dust suppression required at the construction site;

b) Regularly remove and safely disposing of waste material (rock dust) from the site in covered lorries;

c) Waste dust material from stone crushing operations if used for fill shall be covered within 4 hours;

d) Minimize spillage of raw material. Promptly clean up all spillage and accumulations of dust.

e) Fugitive emissions including emissions from stockpiles and other areas shall be minimized as far as practicable. Emissions from these sources shall be substantially free from visible dust emission.

1 General Environmental Protection:

The Contractor shall take steps to protect the environment and surrounding populations from silica dust hazards. Ensure that the water required for dust suppression operations is sourced from a supply that will not impact the quality or availability of water in the surrounding environment. Follow all State requirements for siting criteria and obtain consent from applicable state pollution control board. Ensure that emissions, surface discharges and site closure practices shall comply with all applicable laws including but not limited to:

a) The water (prevention and control of pollution) act 1974; no. 6 of 1974.

b) The air (prevention and control of pollution) act, 1981; no. 14 of 1981.

2 Technical Requirements to Minimize Airborne Dust Emissions

i. General

The handling of raw material, products, wastes or by-products should be carried out as to minimize the release of airborne dust. Use Table below for guidance in employing dust suppression methods.

Feasible Control Measures for Open Dust Sources: Fugitive Emission Control Measure

Source	Enclosures	Wet Suppression	Chemical Stabilization	Green Belt	Surface Cleaning	Wind Break Walls
Unpaved roadways and staging areas		X	X			
Storage piles	X	X	X			X

Stone crushing Operations	X	X		X	X	X

Source	Enclosures	Wet Suppression	Chemical Stabilization	Green Belt	Surface Cleaning	Wind Break Walls
Paved roadways and staging areas					X	
Exposed areas	X	X	X	X		X
Batch drop Operations	X	X				X
Continuous drop Operations	X	X				X

ii. Wet Methods: Water spray Dust Suppression Systems for Stone Crushing Mills

Details of system components for all stone crusher facilities:

(a) Minimum number and locations of pressure spray nozzles:

- 1 nozzle on the top of the crusher
- 2 nozzles at the delivery point of crushing material
- 1 nozzle on the bottom of the vibrator screen or rotary screen
- 2 nozzles within the storage hopper
- 1 nozzle at the delivery point of raw material
- 1 nozzle at the bottom of the dust hopper

(b) A water pump with adequate motor horsepower and discharge pressure as required for optimal performance of spray nozzles.

(c) Covered water storage tank, with a manhole type maintenance provision. The cover should prevent atmospheric dust from entering the tank. The tank can be located at the ground level. Water from a bore well or other source could be pumped to fill the tank periodically.

(d) Centrifugal mono block type self-priming pump capable of delivering 3 to 5 kg/cm2 pressure and 72 liters per minute.

(e) 100 stainless steel mesh online water filter with two parallel cells. Parallel cells should be set up in order for to allow connections to be reversed such that one cell undergoes backwash cleaning while the other cell is in operation. Only filtered water should be supplied to the spray nozzles.

(f) Chemical surfactants or wetting agents may be added to water used in the spraying systems.

(g) All spraying systems used for dust suppression shall be maintained in good condition. The flow rate and operating pressure of the spraying liquid/solution shall be sufficient to suppress dust emissions from the corresponding sources. The spraying system shall be able to cover the areas of emission points concerned.

(h) All water spray equipment shall be operational during all stone crushing operations at the site.

(i) No domestic showers, sprinklers, or other general water spray devices may be substituted for pressure misting nozzles. Nozzles may be hollow cone, solid cone or fan type.

iii. Dry Methods: Dust Extraction Systems for Stone Crusher Mills/ Hot Mix Plants

Details of system components:

(a) Minimum requirements for dry dust capture and collection systems:

- Hood or enclosure to capture emissions;
- Dust collector that separates particulates (e.g. centrifugal dust collectors); and
- Duct to transport particulates in air stream from dust collector to air pollution control device (e.g. bag house).

(b) Capture hoods shall be installed over all crusher units and screens. Enclosures shall surround all sources of dust to the extent possible.

(c) Dust collector shall be connected in-line via an enclosed duct to a cyclone and bag house for dust removal.

(d) Air handling system shall be a suitable size to prevent the escape of untreated airborne dust. Maintain minimum airflow as per design. A minimum draft velocity of 1 meter/ second shall be maintained through all open hoods.

(e) Inspect bag filters routinely and at least once per month for damage and clean, repair or replace as needed.

iv. Dust Containment Enclosures for Stone Crusher Mills and Hot Mix Plants:

Particulate emissions shall be controlled by installing dust containment enclosures at the following locations:

(a) Primary crusher discharge area

Enclosure shall cover discharge areas to all conveyor belts or secondary crusher.

(b) Vibratory screen

All vibratory screens shall be totally enclosed. Screen houses shall be rigid and reasonably dust tight with self-closing doors or close-fitted entrances and exits for access. Where conveyors pass through the screen house, flexible covers should be installed at entries and exits of the conveyors to the housing.

(c) Conveyor belts (optional)

The enclosures should be complete from all the four sides and roof. There should not be any open windows/openings etc. Any opening should be kept closed during operation. The gaps should be sealed using gaskets or wool type packing etc. Crusher enclosures shall be rigid and be fitted with self-closing doors and close-fitting entrances and exits. Where conveyors pass through the crusher enclosures, flexible covers should be installed at entries and exits of the conveyors to the enclosure.

(d). Inlet hopper

The inlet hopper shall be enclosed on three sides.

(e). Rotary dryer`

The plant rotary dryer in a hot mix plant. Malfunctioning or breakdown of equipment leading to abnormal emissions shall be dealt with promptly. In any case, the abnormal emission due to equipment failure shall be stopped as soon as practicable. The dust collection system shall be routinely inspected and maintained in good condition and shall be used as required. The owner shall conduct an inspection of the dust control system at least once per month.

v. Minimize Fugitive Dust From Roadways and Stock Piles

Minimize fugitive dust emissions from all sites where crushed rock is stored. Particulate emissions from unpaved roads and stock piles shall be controlled with the application of suitable compounds to minimize the control of dust. Petroleum-based products, waste oils or other waste products shall never be used for this purpose. Acceptable compounds for this purpose include:

a) Acrylic polymers;

b) Solid recycled asphalt;

c) Chloride compounds (calcium chloride and magnesium chloride);

d) Lignin compounds (lignin sulfate and lignin sulfonate powders);

e) Natural oil resins (soybean oil); and

f) Organic resin emulsions.

Contractor shall provide a product information sheet prepared by the manufacturer or distributor indicating the chemical composition, application instructions, and other environmental, safety and health considerations 30 days in advance of its intended application to Engineer's Representative. The product information shall be reviewed and approved in writing before the contractor proceeds to apply it on the project site.

vi. Minimize Fugitive Dust From Heavy Equipment and Road Transport Vehicles

Minimize fugitive dust emissions from all vehicles when loading, unloading and operating vehicles on project sites, staging areas, or stone crusher mills. Settled dust and particulate emissions from lorries used to transport stone or waste products generated in stone crushing operations, and other heavy construction vehicles, shall be minimized in accordance with the following practices:

Lorries shall be filled with the material using wet methods. Load waste fine material and powders onto tankers or closed trucks through a lengthy sleeve attached to the spout to minimize drop height and dust release.

Lorries once filled with stone or other waste material shall be covered before leaving the site. A single layer impermeable tarp shall be placed over the entire load and secured with rope or other tension bar.

Designate a decontamination area that is required to be used by all vehicles before exiting the site. This area shall be covered with an impervious tarp. Use wet methods to wipe all accessible exterior surfaces of vehicles and tires.

Impose strict speed limits for all vehicles operating on service roads, loading areas, or staging areas.

vii. Minimize Fugitive Dust During Rock Quarry Operations

Particulate emissions shall be controlled during drilling, blasting, loading, and hauling with wet methods using surfactants applied in either water or foam spray.

Dust controls for stone drilling shall use water fed into the compressed air to suppress the dust.

viii. Work Practices for Reducing Employee Exposures

This section pertains to all activities with potential for dust exposure to workers employed in quarries, stone crusher units, hot mix plants, and construction sites.

Use wet methods where feasible to reduce dust emissions from working surface or equipment.

Use a gentle spray or mist to moisten settled dust particles. When washing large quantities of dust from a surface, increase the water force only after pre-wetting all the dust with a gentle spray. Use only the minimum amount of water needed to get the job done without creating runoff.

Rewet surfaces as necessary to control dust.

C. TECHNICAL REQUIREMENTS FOR WORKER MEDICAL SURVEILLANCE

i. General

This section pertains to workers employed in quarries, stone crusher units, and hot mix plants.

ii. Medical Monitoring

Medical monitoring shall be conducted for each worker before the start of work and at least at annually thereafter. Examination shall as a minimum meet requirements as set forth below:

Examination

a) The employer of the worker shall ensure that all medical examinations and procedures are performed by a licensed physician, and are provided at no cost to the employee and at a reasonable time and place.

b) Persons employed under the licensed physicians may administer the pulmonary function testing, chest x-ray or other testing procedures required by this section if adequately trained by an appropriate academic or professional institution.

c) A physical examination directed to the pulmonary system, including a chest x-ray to be administered and pulmonary function tests of forced vital capacity (FVC) and forced expiratory volume at one second (FEV(1)). Interpretation and classification of chest roentgenograms shall be conducted in accordance with ILO classification system. Interpretation of the chest x-ray shall be conducted under the ILO Classification of Radiographs of Pneumoconiosis by a reader trained under this protocol. Evaluate chest x-ray for possible tuberculosis because people exposed to silica have increased susceptibility.

Report from Medical Examination: A report must be submitted from all medical examinations conducted within the last 12 months to document compliance with this medical surveillance requirement for each worker employed in quarries and stone crusher units. Submit, at a minimum, for each worker the following:

Name and Employee Identification Number

Physician's Written Opinion from examining physician including at a minimum the following:

1) Whether worker has any detected medical conditions that would place the worker at an increased risk of material health impairment from exposure to silica.

2) A statement that the worker may wear a negative pressure respirator or any recommended limitations on the worker or on the use of personal protective equipment such as respirators.

3) Statement that the worker has been informed by the physician of the results of the medical examination and of any medical conditions that may result from dust exposure.

iii. Record Keeping

a) The employer shall establish and maintain accurate records of medical surveillance to include the physician's written opinion on each employee's health status.

b) Records shall be maintained for at least the duration of the contract period.

c) A copy of the each employee's records must be provided to the affected employee who has undergone the medical surveillance stipulated above within 30 days of the date of the examination.

D. REQUIREMENTS FOR EMPLOYEE TRAINING

i. General

a) This section pertains to all workers employed in quarries, stone crusher units, hot mix plants, and any construction workers using powered tools or equipment to cut, grind, core, or drill concrete or masonry material. The training provided under this section shall be provided to workers at no cost to these employees and in a language understood by workers at each training program. The course shall be taught by an environmental health and safety specialist with adequate education, experience and training.

b) Incorporate general information about silica dust hazards in all orientation and site training sessions covering health or safety aspects.

ii. Training Topics

The employer shall provide training on the following topics to all employees prior to their assignment to jobs where the employer will be conducting these operations during this project:

a) The potential health hazards of exposure to airborne silica dust including silicosis, tuberculosis, lung cancer, chronic obstructive lung disease (COPD) and decreased lung function.

b) Methods used by the employer to control employee exposures to airborne silica dust including wet or dry methods for stone crushing, drilling, cutting, local exhaust ventilation systems, and isolation of the process from employees by means of distance, enclosure, or other means, as applicable.

c) Proper use and maintenance of dust reduction systems, including the safe handling and disposal of waste material.

d) The importance of good personal hygiene and housekeeping practices when working in proximity to silica dust including:

- Not smoking tobacco products; appropriate methods of cleaning up before eating, and appropriate methods of cleaning clothes.
- Avoiding, to the extent practical, activities that would contribute significantly to exposure to airborne dusts.

E. WORKER PROTECTION

i. General

Contractors shall supply respirators and other specified safety equipment to all workers employed in quarries, stone crusher units, hot mix plants, and any construction workers using powered tools or equipment to cut, grind, core, or drill concrete or masonry material as described below:

a. Do not eat, drink, smoke, chew or smoke tobacco in the work area. To eat, drink, chew, or smoke, workers shall follow the procedures described below and leave the work area.

b. Provide workers with a clean source of water for a facility to wash hands and face with soap and water. This should be done before eating, smoking or drinking and at the end of the day before going home. Hand washing facilities shall be set up adjacent to the work area.

c. Engineering and work practice controls must be used whenever the possibility exists that employee may be exposed to silica including during stone crushing and construction operations.

d. The use of compressed air, dry sweeping, or any cleaning method that would cause elevated silica dust air concentrations are prohibited.

ii. Respiratory Protection

Minimum Respiratory Protection: Require that the minimum level of respiratory protection used be Respirator Class FFP3 under European standard EN 143 or N99 under the U.S. National Institute for Occupational Safety and Health (NIOSH) classification. Respirators shall be single use disposal respirators for dusts or reusable half-face air-purifying respirators with high efficiency particulate air filters.

Require that a respirator be worn by anyone in a Work Area at all times during any operation. Do not allow the use of surgical masks or other types of disposable respirators not specified above for any purpose.

Fit testing shall be conducted on any reusable air-purifying respirator assigned to the worker.

Only assign respirators to workers medically approved to wear negative pressure respirators as per the physicians' written opinion following an annual medical examination as per the requirements in Part 3 of this addendum.

iii. Protective Equipment

Do not allow workers to leave the work place wearing any clothing or equipment worn during the work shift. Provide the following:

a) Eye Protection: Provide eye protection as needed for the type of work being performed.

b) Shoes: Provide shoes to all workers and require that they be worn at all times in the Work Area.

c) Hearing protection: Provide all workers at all quarries, stone crushing sites, and hot mix plants and all other workers exposed to loud noise with ear plugs or other suitable hearing protection.

F. EMISSION AND AMBIENT AIR LIMITS

i. General

Contractors shall conduct all required emissions monitoring as required to prove compliance with all applicable State Pollution Control Board Regulations and the limits specified within this section. This section applies to all permanent and temporary stone crushing mills and hot mix plants.

ii. Suspended Particulate Matter (SPM)

The Suspended Particulate Matter (SPM) at a distance of 40 meters from a stone crusher unit in a cluster should be less than 600 micro gram per cubic metre (micro-gm/Nm3).

The concentration of total particulate matter in any contained emissions to air, for example the bag filter exhaust air outlet, shall not exceed 150 ug per cubic metre (150ug/Nm3). The introduction of dilution air to achieve the emission concentration limits shall not be permitted.

Monitoring of the 24-hour average concentration of the total suspended particulate and/or respiratory suspended particulate in ambient air shall be conducted at the site boundary and/or any other locations to be agreed by the Authority. SPM sampling shall conform to the United State Environmental Protection Agency's Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-volume Method) and shall be conducted at a frequency of not less than once every 6 months.

G. CHAIN-OF-CUSTODY FOR CRUSHED STONE

i. General

Contractor shall maintain records of suppliers for each load of crushed stone brought to the construction site with the procedures as outlined below. Such records shall be collected at a central location at least monthly during the duration of the project and be available for inspection by Engineer's Representative.

ii. Supplier Validation

Contractor shall maintain records of all suppliers and all internally sourced supplies of crushed stone brought to the construction site to include:

a) Name of supplier;

b) Location of stone crusher operation;

c) Location and name of the quarry;

d) Proof of registration and consent from the applicable Mining Department;

e) Proof of registration and consent for operation from applicable Pollution Control Board;

f) The supplied material size and quantity (by weight or volume);

g) Date and specific location material was brought to site.

H. RESTORATION OF TEMPORARY STONE CRUSHER SITES

i. General

This section applies to the removal of any temporary stone crusher sites established and used during the duration of the project. During operation all temporary operations shall meet the requirements specified in Parts 1 and 2 above.

ii. Equipment removal

Temporary equipment shall be cleaned before being taken down and prepared for off-site transport. Clear off all temporary structures and garbage.

iii. Site restoration

Remove all debris and visible accumulations of dust from ground surfaces. Cover all bare soil surfaces with vegetation or pavement to reduce exposure to residual silica dust.

(End of Appendix-6)

APPENDIX-7: PMIS REQUIREMENTS AND PROCEDURES

1. GENERAL

1.1 Timely performance is of the essence on this project. The Contractor may complete the project or any part of the Project earlier than is stipulated in the Contract and the Milestone requirements.

1.2 The Contractor shall devise and utilize a Project Management Information System (PMIS) such that all documents generated by the Contractor can be transmitted to the Engineer by electronic means (and vice versa) and that all documents generated by either party are electronically captured at the point of origin and can be reproduced later, electronically and in hard copy. A similar link shall also be provided between the Engineer Office at site and the Employer's site office and Headquarter Office by the Contractor.

1.3 All design and/or construction work, including all sub-contractors' work, under this Contract shall be planned, scheduled, executed, reported and accomplished using the precedence diagramming Critical Path Method (hereinafter referred to as CPM). The work required by this section includes the requirement to prepare, maintain, and update all detailed schedules as described in this section. The CPM schedules shall be prepared in such a manner as to permit the orderly planning, organization, and execution of the Work and be sufficiently detailed to accurately depict all the work required by the Contract. The Contractor shall resource (labor and equipment) and cost load its schedule as specified herein.

1.4 All schedules and schedule submittals under this Contract shall be computerized by the Contractor utilizing Professional Project Management Software, Oracle Primavera P6 or latest revision or any other software approved/instructed by Engineer capable of integrating with PMIS with the Engineer and the Employer.

1.5 The primary objectives of the requirements of this section are:

1) To ensure adequate planning and execution of the Works by the Contractor;

2) To assist the Engineer in evaluating progress of the Works;

3) To provide optimum coordination with other designated contractor or Sub-contractors and suppliers, within its jurisdiction.

4) To permit timely prediction or detection of events or occurrences which may affect the timely execution of the Works;

5) To establish a system to enable the Engineer to monitor the various activities carried out by the contractor to achieve the preset milestone to the timescale to meet the requirements of the contract document for completing the specified work in the contract.

1.6 The Contractor is responsible for determining the sequence of activities, the time estimates for the detailed design and construction activities and the means, methods, techniques and procedures to be employed. The schedules identified herein shall represent the Contractor's best judgment of how it will execute the Work in compliance with the Contract requirements. The Contractor shall ensure that the schedule is current and accurate and is properly and timely monitored, updated and revised as project conditions may require and as required by the Contract documents.

1.7 The Contractor shall provide the basic data relating to activities, durations, specified

Contract Milestones, and sequences to the Engineer, as part of Contractor required schedule submittals. This data shall reflect the Contractor's actual plan for the project, and shall fully comply with all requirements of the Contract documents.

1.8 Subject to the Engineer's agreement and unless identified elsewhere in the Contract documents, the Contractor shall determine when, where, and how it will interface with others performing work on the program and to coordinate its activities with all parties including the Employer and its consultants, suppliers and other contractors.

1.9 The Contractor shall include in the interim schedule and Contract baseline schedule all interface points with others. These points shall be in the form of start milestones for deliverables due to the Contractor from others and as Finish Milestones for deliverables that Contractor must supply to others.

2. SCHEDULER QUALIFICATIONS

The Contractor shall have within its employment or under contract, throughout the execution of the Work, such expertise in CPM scheduling and experience so as to ensure its effective and efficient performance under this Contract.

3. SCHEDULE ORIENTATION SESSION

3.1 The Contractor shall, upon notification from the Engineer, attend a schedule orientation session relating to the schedules and reports requirements for this Contract. The schedule orientation session is designed to review in detail, the objectives of the schedules and reports requirements and the contract requirements. The Contractor shall arrange for its Project Manager, superintendent, and scheduler to attend the schedule orientation session.

3.2 The following items shall be discussed during the schedule orientation session:

1) The procedures and requirements for the preparation of the interim schedule, contract baseline schedule, and monthly updates by Contractor;
2) How the requirements of the Contract documents will be monitored and enforced by the Engineer;
3) Long-lead items and time requirements for the Work by sub-contractors will be identified and included in the contract baseline schedule;
4) Work packages;
5) Coding and logic for the contract baseline schedule; and
6) Identification and scheduling of Shop Drawings and other submittals;
7) Listing of major project milestones;
8) Cost loading of major project summary activities.

4. INTERIM SCHEDULE

4.1 The Contractor shall submit its interim schedule, to the Engineer for review and acceptance at the Pre-Construction conference (or kick-off meeting for the Design portion of the project) indicating a detailed work plan for the first fifty six (56) days from the Commencement Date. Work beyond the first fifty six (56) days shall also be indicated in summary form.

4.2 The interim schedule detail plan shall include but not be limited to planned mobilization, sequence of early operations, submittals and procurement of materials and equipment. The interim schedule shall also include the following information as a minimum:

1) Activity identification number of the task or event;
2) Description of the task or event;
3) Duration of the task or event;
4) Earliest start and finish dates for the task or event;
5) Latest start and finish dates for the task or event;
6) Various stages of Design development and Construction completion
7) Milestones for activities given in this document and consequent critical points for interface with others.
8) Logic links to previous tasks upon which the task is dependent before it can start and to subsequent tasks which are dependent on the task to be completed before they can commence

4.3 During the first fifty six (56) days following the Commencement Date, the interim schedule shall be updated regularly and submitted to the Engineer to indicate the progress of the Work, unless the contract baseline schedule is approved within fifty six (56) days of Commencement Date. Once the contract baseline schedule is accepted by the Engineer, no further updates of the interim schedule are required.

5. CONTRACT BASELINE SCHEDULE

5.1 Within forty-two (42) calendar days after the Commencement Date the Contractor shall complete the contract baseline schedule, which expands the accepted interim schedule, and submit it to the Engineer for review and acceptance. The contract baseline schedule submittal shall not show any progress until it is accepted by the Engineer.

5.2 The Contractor shall submit to the Engineer a complementary and detailed narrative description of its plan for performing the Work with the submittal of the contract baseline schedule. The narrative description shall summarize the overall approach to design and/or construction sequencing, including, but not be limited to:

1) The anticipated lost days due to weather;
2) The equipment and personnel requirements by craft to complete a resource loaded schedule;
3) Whether it proposes the Work be performed on single, double or triple shifts;

5.3 No application for payment shall be accepted until the contract baseline schedule is approved.

6. CEPTANCE OF THE INTERIM SCHEDULE AND CONTRACT BASELINE SCHEDULE

6.1 Engineer and the Contractor shall review and discuss the interim schedule or contract baseline schedule after it has been submitted to the Engineer.

6.2 the Engineer accepts the interim schedule and contract baseline schedule, these schedules will then be used to monitor and record progress of the Work, forecast completion dates, evaluate revisions and generate the payment application amounts, where applicable. Acceptance of the interim schedule or the contract baseline schedule by the Engineer shall not relieve the Contractor of total responsibility for the Contractor's means and methods, scheduling, sequencing, and prosecuting the Work to comply with the requirements of the Contract.

6.3 Engineer shall have the right to require the Contractor to revise and resubmit the interim schedule and the contract baseline schedule to modify any Contractor data in the schedules or any portion of the schedules that the Engineer determines to be:

1) Impracticable;

2) Based upon erroneous calculations or estimates;

3) Unreasonable;

4) Required in order to ensure proper coordination by the Contractor of the work of its Sub-contractors and with the work or services being provided by any separate contractors;

5) Necessary to avoid undue interference with plant operations or those of any utility owners or adjoining property owners;

6) Necessary to ensure completion of the Work by the Contract Milestones and Contract completion dates set forth in the Contract documents;

7) Required in order for Contractor to comply with any other requirements of the Contract documents;

8) Not in accordance with the Contractor's actual operations, unless the revision or modification will change the original scope of Works. The Contractor shall bear the expense of such revisions. If the Engineer requires such revisions, the Contractor shall revise the interim schedule or contract baseline schedule and submit it for Engineer's acceptance within seven (7) calendar days.

6.4 Engineer reserves the right to require that the Contractor to adjust, add to, or clarify any portion of the schedules that may be determined to be insufficient for monitoring of the Work after the schedules are accepted. No additional compensation shall be provided for such adjustments, additions or clarifications.

7. SCHEDULE CONTENT AND FORMAT

7.1 All construction activity durations shall be given in working days. The Contractor shall develop activities for the schedules so that no single activity shown has duration longer than fourteen (14) working days, except for procurement and fabrication, delivery, submittal development and approval activities that may have longer durations.

7.2 For all equipment and materials to be fabricated or supplied for the Project, the contract baseline schedule shall show a sequence of activities including:

1) Material delivery and storage;

2) Erection or installation;

3) Testing of equipment and materials.

7.3 The interim schedule and contract baseline schedule shall show dependencies (or relationships) between each activity. Each activity must have a successor and predecessor, except for the project start and finish milestone. The use of date constraints shall be limited to Contract milestones and Contract completion dates only.

7.4 The interim schedule and contract baseline schedule shall contain or be able to demonstrate that the following items have been addressed:

1) The Project's name;
2) The Contractor's name;
3) Revision or edition number;
4) Activities of completed work;
5) Activities relating to different areas of responsibility, such as subcontracted Work which is distinctly separated from that being done by the Contractor directly;
6) Labour resources distinguished by craft or crew requirements;
7) Equipment and material resources distinguished by equipment and material requirements;
8) Distinct and identifiable subdivisions of work such as structural slabs, beams, columns;
9) Locations of work within the contract limit lines that necessitates different times or crews to perform;
10) Outage schedules for existing utility services that will be interrupted during the performance of the Work;
11) Acquisition and installation of equipment and materials supplied and/or installed by the owner or its separate contractors;
12) Material to be stored on Site;
13) Phases;
14) Interim milestones and the Contract Completion dates.

7.5 The Contractor shall be responsible for expediting the delivery of all materials and equipment to be furnished by the Contractor so that the progress of construction shall be maintained according to the currently accepted contract baseline schedule for the Works. The Contractor shall notify the Engineer in writing, and in a timely manner, whenever the Contractor anticipates that the delivery date of any material or equipment will be later than the delivery date indicated by the currently accepted contract baseline schedule.

8. MONHLY SCHEDULE UPDATE

8.1 An update of the accepted interim schedule or contract baseline schedule shall be submitted by the Contractor to the Engineer monthly and with the monthly application for payment. Receipt by the Engineer of the monthly schedule update will be an express condition precedent to processing each invoice.

8.2 On a monthly basis, the Contractor shall arrange for its Project Manager, superintendent, and scheduler to meet at the project Site with the Engineer to review Contractor's monthly schedule update. The schedule will be marked-up to show the agreed upon progress, signed by the Contractor, and a signed copy issued to the Project Manager. The monthly schedule update shall show up-to-date and accurate progress of the Works, and shall forecast the completion date for activities in progress based on the contract baseline schedule. The monthly schedule update shall be prepared by the Contractor in consultation with all its principal sub- contractors and suppliers.

8.3 The monthly schedule update shall include actual activity data for progress to date, but in the monthly schedule update, the Contractor shall not change the schedule logic, the activity relationships/dependencies, or planned activity durations and shall not add or delete activities. If the Contractor believes that any of these items should be changed, then a proposed revised baseline schedule must be submitted by the Contractor to the Engineer. Although activities shall not be added or deleted in the monthly schedule update, activities associated with Work authorizations that have been recommended for approval shall be included in the next monthly schedule update.

8.4 The Contractor will be notified by the Engineer, in writing, as to acceptance, reasons for rejection, or any revisions required to the schedules. Changes to the schedules agreed upon by the Contractor and the Engineer shall be incorporated by the Contractor into the schedules within seven (7) calendar days after agreement.

8.5 The monthly schedule update shall show actual activity commencement and completion dates, the actual remaining duration in workdays and physical percent complete for those activities commenced and not complete. For the stored materials, the update shall show the amount of material stored, representing the total cost of the materials delivered and properly stored. The monthly schedule update shall also show a graphic comparison of the current status and the baseline plan for each activity in the network.

8.6 Each monthly schedule update shall continue to show all work activities including those already completed. These completed activities shall accurately reflect "as built" information by indicating when activities were actually started and completed.

8.7 Monthly schedule updates shall also contain the following information for each activity:

1) Activity identification number, description and estimated original duration in workdays;
2) Calculated early and late finish dates;
3) Actual start and actual finish dates, and remaining duration, in calendar, for those activities started and not completed;
4) Days ahead and/or behind schedule of the milestones representing the specified Contract Milestones and Contract completion dates;
5) Physical percent complete for each activity;
6) A float analysis of the longest path through the schedule detailing potential delays and areas for acceleration. Actual start and finish dates shall be indicated for each activity as appropriate. Completed activities will be omitted from remaining float and late start slots.

9. REVISED BASELINE SCHEDULE

9.1 If the current contract baseline schedule or monthly schedule update no longer represents the actual or planned execution and progress of the Work, the Contractor shall submit a proposed revision to the current contract baseline schedule to the employer in accordance with the section at no additional cost If the Engineer believes that the current contract baseline schedule or monthly schedule update no longer represents the actual or planned execution and progress of the Work, the Contractor shall submit, a proposed revision to the current contract baseline schedule to the employer in accordance with this section at no additional cost.

9.2 Schedule Revisions, as defined herein, shall refer to modifications made to activities in the accepted interim schedule or contract baseline schedule in any of the following items:

1) Activity duration;
2) Changes in logic connections between activities;
3) Changes in constraints;

4) Changes in value loading;

5) Changes to activity descriptions;

6) Activity additions and deletions.

9.3 Any proposed revisions to the contract baseline schedule must be submitted to the Engineer for acceptance. This submittal must include, at a minimum, a written narrative with a full description and reasons for each work activity revised a full schedule printout, and a soft copy of the proposed revised contract baseline schedule. For revisions affecting the sequence of work, the Contractor shall provide a schedule diagram Fragmented Network (Fragnet) which compares the original sequence to the revised sequence of work. This diagram shall maintain the Contract Milestone and Contract completion dates.

10. RECOVERY SCHEDULE

10.1 Should the updated interim schedule, contract baseline schedule or monthly schedule update, at any time during Contractor's performance, show that the Contractor is fourteen (14) or more calendar days behind schedule for any Contract interim Milestone, substantial completion or for Contract completion, the Contractor shall prepare a recovery schedule separate from the updated and approved monthly schedule update explaining and displaying how the Contractor intends to reschedule its work in order to regain compliance with the contract baseline schedule during the immediate subsequent pay period.

10.2 If a recovery schedule is required, the Contractor shall prepare and submit to the Engineer a recovery schedule, incorporating the best available information from sub-contractors and others, which will permit the forecasted completion dates to return to the interim milestones and the Contract completion dates. The Contractor shall prepare a recovery schedule to the same level of detail as the originally accepted contract baseline schedule submittal.

10.3 Within seven (7) working days after submission of the recovery schedule, the Contractor shall meet with the Engineer to review and evaluate the recovery schedule. Within seven (7) working days of that meeting, the Contractor shall submit the recovery schedule, including any revisions necessitated by the review, to the Engineer for its review and acceptance. The recovery schedule, once accepted by the Engineer, shall be implemented as the revised contract baseline schedule for the remaining Work.

(End of Appendix-7)

APPENDIX-8: LIST OF LEVEL CROSSING

Sr. No	LC. No.	Chainage
1		NIL

(End of Appendix-8)

APPENDIX-9: ENVIRONMENTAL, SOCIAL, HEALTH AND SAFETY (ESHS) METRICS FOR PROGRESS REPORTS

Metrics for regular reporting:

a. environmental incidents or non-compliances with contract requirements, including air, noise, , water, soil quality monitoring, analysis and contamination, pollution or damage to ground or water supplies;

b. health and safety incidents, accidents, injuries and all fatalities that require treatment;

c. interactions with regulators: identify agency, dates, subjects, outcomes (report the negative, if none);

d. status of all permits and agreements:

   i. work permits: number required, number received, actions taken for those not received;

   ii. status of permits and consents:

      - list areas/facilities with permits required (quarries, asphalt & batch plants), dates of application, dates issued (actions to follow up if not issued), dates submitted to resident engineer (or equivalent), status of area (waiting for permits, working, abandoned without reclamation, decommissioning plan being implemented, etc.);
      - list areas with landowner agreements required (borrow and spoil areas, camp sites), dates of agreements, dates submitted to resident engineer (or equivalent);
      - identify major activities undertaken in each area this month and highlights of environmental and social protection (land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation);
      - for quarries: status of relocation and compensation (completed, or details of monthly activities and current status).

e. health and safety supervision:

   i. safety officer: number days worked, number of full inspections & partial inspections, reports to construction/project management;

   ii. number of workers, work hours, metric of PPE use (percentage of workers with full personal protection equipment (PPE), partial, etc.), worker violations observed (by type of violation, PPE or otherwise), warnings given, repeat warnings given, follow-up actions taken (if any);

f. worker accommodations:

   i. number of expats housed in accommodations, number of locals;

   ii. date of last inspection, and highlights of inspection including status of accommodations' compliance with national and local law and good practice, including sanitation, space, etc.;

   iii. actions taken to recommend/require improved conditions, or to improve conditions.

g. HIV/AIDS: provider of health services, information and/or training, location of clinic, number of non- safety disease or illness treatments and diagnoses (no names to be provided);

h. gender (for expats and locals separately): number of female workers, percentage of workforce, gender issues raised and dealt with (cross-reference grievances or other sections as needed);

i. training:

   i. number of new workers, number receiving induction training, dates of induction training;

   ii. number and dates of toolbox talks, number of workers receiving Occupational Health and Safety (OHS), environmental and social training;

   iii. number and dates of HIV/AIDS sensitization training, no. workers receiving training (this month and in the past); same questions for gender sensitization, flaglady/flagman training.

j. environmental and social supervision:

   i. environmentalist: days worked, areas inspected and numbers of inspections of each (road section, work camp, accommodations, quarries, borrow areas, spoil areas, swamps, forest crossings, etc.), highlights of activities/findings (including violations of environmental and/or social best practices, actions taken), reports to environmental and/or social specialist/construction/site management;

   ii. sociologist: days worked, number of partial and full site inspections (by area: road section, work camp, accommodations, quarries, borrow areas, spoil areas, clinic, HIV/AIDS center, community centers, etc.), highlights of activities (including violations of environmental and/or social requirements observed, actions taken), reports to environmental and/or social specialist/construction/site management; and

   iii. community liaison person(s): days worked (hours community center open), number of people met, highlights of activities (issues raised, etc.), reports to environmental and/or social specialist /construction/site management.

k. Grievances: list this month's and unresolved past grievances by date received, complainant, how received, to whom referred to for action, resolution and date (if completed), data resolution reported to complainant, any required follow-up(Cross-reference other sections as needed):

   i. Worker grievances;

   ii. Community grievances

l. Traffic and vehicles/equipment:

   i. traffic accidents involving project vehicles & equipment: provide date, location, damage, cause, follow-up;

   ii. accidents involving non-project vehicles or property (also reported under immediate metrics): provide date, location, damage, cause, follow-up;

   iii. overall condition of vehicles/equipment (subjective judgment by environmentalist); non- routine repairs and maintenance needed to improve safety and/or environmental performance (to control smoke, etc.).

m. Environmental mitigations and issues (what has been done):

   i. dust: number of working bowsers, number of waterings/day, number of complaints, warnings given by environmentalist, actions taken to resolve; highlights of quarry dust control (covers, sprays, operational status); % of rock/muram/spoil lorries with covers, actions taken for uncovered vehicles;

   ii. erosion control: controls implemented by location, status of water crossings, environmentalist inspections and results, actions taken to resolve issues, emergency repairs needed to control erosion/sedimentation;

iii. quarries, borrow areas, spoil areas, asphalt plants, batch plants: identify major activities undertaken this month at each, and highlights of environmental and social protection: land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation;

iv. blasting: number of blasts (and locations), status of implementation of blasting plan (including notices, evacuations, etc.), incidents of off-site damage or complaints (cross- reference other sections as needed);

v. spill cleanups, if any: material spilled, location, amount, actions taken, material disposal (report all spills that result in water or soil contamination;

vi. waste management: types and quantities generated and managed, including amount taken offsite (and by whom) or reused/recycled/disposed on-site;

vii. details of tree plantings and other mitigations required undertaken this month;

viii. details of water and swamp protection mitigations required undertaken this month.

n. compliance:

i. compliance status for conditions of all relevant consents/permits, for the Work, including quarries, etc.): statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance;

ii. compliance status of ESMP/ESIP requirements: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

iii. other unresolved issues from previous months related to environmental and social: continued violations, continued failure of equipment, continued lack of vehicle covers, spills not dealt with, continued compensation or blasting issues, etc. Cross-reference other sections as needed.

(End of Appendix-9)

APPENDIX-10: LIST OF BRIDGES

The indicative list of major bridges in Prithla – Harsana Kalan section and connections are as under. The actual number of bridges and their configuration may be ascertained by the Contractor through actual site survey and through interface with concerned CST Contractors. Contractor shall carry out interface with CST contractors for bridge mast arrangement and other suitable arrangement for installation of OHE.

A: MAJOR BRIDGE LIST OF MAIN LINE FOR HORC PROJECT

SN	BR. No	Chainage (m)	Type of Bridge	Span Configuration	Bank Height (m)
1	11	1,696.625	PSC U-SLAB	1X12.2	6.11
2	15	3,476.865	PSC U-SLAB	1X12.2	5.70
3	16	4,242.015	OWG	4X30.5	6.27
4	17	4,376.033	PSC U-SLAB	1X12.2	6.78
5	25	7,759.415	PSC U-SLAB	1X12.2	7.04
6	27	8,036.572	OWG	1X61	5.88
7	29	8,298.329	Composite	1X30.5	8.25
8	33	9,537.119	PSC I Girder	1X30.5	5.69
9	46	11,543.737	OWG	2X76.2	6.85
10	54	14,472.344	Composite	2X24.4	6.93
11	85	33,673.535	PSC U-Slab	1X12.2	5.66
12	87	34,899.536	PSC U-Slab	3x12.2	5.51
13	90	36,984.623	PSC U-Slab	1x12.2	5.64
14	93	38,457.244	PSC U-Slab	1X12.2	5.73
15	95	40,003.961	PSC U-Slab	1X12.2	5.75
16	106	44,246.256	PSC I Girder	1X18.3	11.55
17	111	45,496.699	OWG + Composite	4X18.3 +1X30.5 +8X24.4 + 1X76.2 +2X24.4+1X61	6.96
18	123	48,664.440	PSC I Girder	1X18.3	5.21
19	134	54,505.980	OWG	1X76.2	6.66
20	136	55,719.028	CG+ OWG	(1x24.4)+(1X76.2) +(1x24.4)	12.08
21	154	61,676.032	OWG, Composite	(2x24.4)+(1x45.7) +(4x24.4)	8.93
22	177	68,213.000	PSC U SLAB	1X12.2	5.65
23	178	68,450.000	RCC Pipe	1X1.8	4.66
24	182	69,684.000	PSC U SLAB	1X12.2	5.65
25	183	69,838.000	Composite Girder	2X30.5	9.33
26	184	70,234.000	PSC U SLAB	1X12.2	5.00
27	199	74,622.000	OWG	(1X76.2)+(1X45.7) +(1X76.2)	5.74
28	200	74,888.000	PSC U SLAB	1X12.2	7.23
29	206	77,547.000	PSC U SLAB	1X12.2	5.72

30	207	77,623.000	PSC U SLAB	2X12.2	5.73
31	214	79,053.209	PSC U SLAB	2X12.2	5.51
32	219	80,182.716	PSC U SLAB	1X12.2	3.79
33	223	81,282.713	PSC U SLAB	1X12.2	4.36
34	224	81,356.937	Composite	1x18.3	5.13
35	228	82,134.530	PSC U SLAB	2X12.2	6.13
36	233	83,056.241	Composite	1X30.5	2.76
37	234	83,236.296	PSC U SLAB	1X12.2	5.33
38	241	84,506.206	OWG	(3X18.3)+(1 X61)	6.10
39	246	85,858.749	OWG	1X30.5	5.24
40	247	86,017.943	PSC U SLAB	1X12.2	4.61
41	249	86,543.863	PSC U SLAB	1X12.2	5.68
42	250	86,783.861	PSC U SLAB	1X12.2	5.60
43	256	89,079.505	OWG	1X30.5	6.64
44	258	89,505.336	Composite	1X30.5	7.85
45	259	89,629.052	PSC U SLAB	1X12.2	7.61
46	266	91,965.902	OWG	(1X24.4)+(1 X45.7) +(1X24.4)	6.45
47	272	93,141.460	OWG	(1X61)+(1X4 5.7)	7.01
48	277	94,382.321	OWG	3X30.5	8.82
49	279	94,725.364	Composite	1X18.3	10.10
50	280	94,864.920	Composite, PSC U SLAB	(1X12.2)+(1 X24.4) +(1X12.2)	8.32
51	282	95,456.349	PSC U SLAB	1X12.2	6.82
52	286	96,516.613	OWG	1X45.7	4.11
53	296	99,227.902	PSC U SLAB	1X12.2	5.67
54	298	99,719.795	Composite, PSC U SLAB	(1X12.2)+(2 X30.5) +(1X12.2)	4.21
55	305	1,01,091.292	OWG		7.44
56	308	1,01,627.564	PSC U SLAB	1X12.2	3.92
57	312	1,02,702.818	PSC U SLAB	2X12.2	4.07
58	329	1,06,828.846	PSC U SLAB	1X12.2	5.43
59	346	1,11,211.933	OWG	6X30.5	8.27
60	348	1,11,729.547	PSC U SLAB	1X12.2	7.19
61	351	1,12,351.582	PSC U SLAB	1X12.2	4.61
62	352	1,12,990.829	PSC U SLAB	1X12.2	4.93
63	372	1,17,497.378	PSC U SLAB	1X12.2	5.88
64	374	1,18,380.419	PSC U SLAB	1X12.2	12.25
65	375	1,18,626.180	OWG	2X61	8.16
66	378	1,19,574.924	PSC SLAB	1X12.2	6.91
67	383	1,20,863.049	OWG	1X30.5	6.23
68	389	1,23,140.157	PSC SLAB	1X12.2	6.38
69	390	1,23,239.082	OWG	2X30.5	6.98

S: MAJOR BRIDGE LIST OF HORC (CONNECTING LINE)

SN	BR. No	Chainage	Type of Crossing	Type of Bridge	Span Configuration
NEW PATLI TO PATLI (C-2)					
1	147(A)	1,200.000	RUB	OWG	1X45.7
NEW PRITHLA TO PRITHLA (C-5					

2	3	-821.629	Composite	RCC Box	(1x6.7x5.5) +(1x24.4)+(16x5.5)
MANDOTHI TO ASAUDHA (C-6)					
3	5	2678.217	COMPOSITE GIRDER	OWG	1X24.4X5.6
4	6	2781.434	RUB, COMPOSITE GIRDER	OWG	1X24.4X5.6
MEWAT TO DHULAWAT(C-3)					
5	1	1240		OWG	4X45.7
6	4	2032		OWG	2X30.5
7	5	2157		PSC U SLAB	1X12.2

(End of Appendix-10)

APPENDIX-11: LIST OF TRANSMISSION LINES 66kV AND ABOVE

The indicative list of power line crossings, 66 kV and above, crossing the HORC lines are given below. The list 'A" crossings have been modified and have adequate clearances from Rail level and list "B" crossings are under the process of modification by HRIDC and shall be modified in due course. Contractor to carry out the survey of these crossing and design shall be carried out while considering these indicative crossings.

A: Power Line Crossings 66 kV and above (modified) (indicative)

Sr. No.	Section	Feeder	Voltage KV	Owner	HORC CH
1	C1	Sec-95	220 KV	HVPNL	50+660
2	C1	Sec-95	220 KV	HVPNL	52+930
3	C1	Sec-95	220 KV	HVPNL	52+970
4	C1	Sec-95	220 KV	HVPNL	4+294
5	C2	Agra - Jhatikra Line	765 KV	PGCIL	60+020
6	C2	Sec-95 - Mau Line	220 KV	HVPNL	2+590
7	C2	Agra - Jhatikra Line	765 KV	PGCIL	2+000
8	C2	Dhanonda - Daulatabad Line	400 KV	HVPNL	3+800
9	C2	Dhanonda - Daulatabad Line	400 KV	HVPNL	3+380
10	C3	Agra - Jhatikra Line	765 KV	PGCIL	36+060
11	C 4	Agra - Jhatikra Line	765 KV	PGCIL	28+200
12	C 5	BTPS-Alwar	220 KV	HVPNL	00+815
13	C 5	Prithla - Kaderpur Line	400 KV	GPTL	03+070
14	C 5	Ballabhgarh - Agra Line	400 KV	PGCIL	05+676
15	C 6	Kanpur - Jhatikra Line	765 KV	PGCIL	63+637
16	C 6	Khetri - Jhatikra Line	765 KV	PGCIL	63+900
17	C 6	Nimribali (Bhiwani)	765 KV	PGCIL	70+770
18	C 6	Jhajjar - Mundka Line	400 KV	APCPL	81+313
19	C 6	Bahadurgarh - Sampla Line	400 KV	PGCIL	88+000
20	C 6	Bawana - Bahadurgarh	400 KV	PGCIL	89+627
21	C 6	Asaudha - Allied Strips Line	132 KV	HVPNL	94+685
22	C 6	JHJI - Rai Line	220 KV	HVPNL	123+381
23	C 6	KAB - DIP Line	400 KV	HVPNL	126+310

B: Power Line Crossings 66 kV and above (unmodified) (indicative)

Sr. No.	Section	Feeder	Voltage KV	Owner	HORC CH
1	C1	Manesar-Pataudi	66 kV	HVPNL	50+040
2	C1	Sec 95-Mau line LILO at Transport Nagar	220 kV	HVPNL	53+000
3	C1	Harsaru-Pataudi line	66 kV	HVPNL	54+400
4	C1	Sec 95-Mau line	220 kV	HVPNL	54+825

5	C2	Harsaru-Farukhnagar line	66 kV	HVPNL	59+195
6	C2	Dadri-Samaypur-bahadurgarh line	220 kV	BBMB	59+280
7	C2	Dhanonda-Daulatabad line	400 kV	HVPNL	60+210
8	C2	Sec 95-Mau line	220 kV	HVPNL	01+860
9	C3	Taudu-Mehmoodpur Ahil line	66 kV	HVPNL	33+340
10	C3	Badshahpur-Rewari line	220 kV	HVPNL	41+200
11	C3	Manesar-Neemranan line	400 kV	PGCIL	44+030
12	C3	Panchgaon-Farukhnagar line on 220 KV Multicircuit tower	66 kV	HVPNL	44+270
13	C3	Sohna-Tauru line	66 kV	HVPNL	02+100
14	C3	Kanpur-Jhatikra line	765 kV	PGCIL	02+950
15	C4	Agra-Jhatikra line	765 kV	PGCIL	28+200
16	C4	Sohna-Tauru line	66 kV	HVPNL	29+350
17	C5	Gurgaon-Rangala Rajpur line	220 kV	HVPNL	16+850
18	C5	Sec-72-Rangala Rajpur LILO line (IMT Sohna)	220 kV	HVPNL	19+950
19	C5	Sohna-Nuh Nagina line	66 kV	HVPNL	20+500
20	C6	Jharli-Daulatabad line	400 kV	HVPNL	63+220
21	C6	Badli-Badsa line	132 kV	HVPNL	73+886
22	C6	Badhana- Nunamajran line	132 kV	HVPNL	84+136
23	C6	Sampla-Bahadurgarh line	220 kV	HVPNL	90+910
24	C6	Bahadurgarh-Bawana-Bhiwani line	400 kV	PGCIL	100+808

(End of Appendix-11)

APPENDIX-12: LIST OF POWER LINE CROSSING 33kV AND BELOW

The indicative list of power line crossings, 33 kV and below, crossing the HORC lines are given below. These crossings are being modified through underground cables and these crossings are under the process of modification by HRIDC and work shall be completed in due course. Contractor to carry out the survey of these crossing and foundation design shall be carried out while considering these indicative crossings.

Sr. No.	Feeder Description	Owner/ Authority	Voltage (kV)	HORC CH
1	HT Line Shifting with 22 Nos Pole	DHBVNL	11 KV	(-1+500) To (-2+200)
2	HT CROSSING 11 KV (UG)+5 Nos pole shifting	DHBVNL	11 KV	(-1+280)
3	HT Crossing 11 KV (UG)	DHBVNL	11 KV	(-900)
4	HT Crossing 11 KV (UG)	DHBVNL	11 KV	(-320)
5	Ht crossing 11KV(UG)+T/F(25KVA) shifting+3 nos pole	DHBVNL	11 KV	0+130
6	HT Crossing 11 KV (UG) T/F 25KVA+ 5 NoS Pole	DHBVNL	11 KV	0+900
7	HT Crossing 11 KV (UG)& 1 POLE SHIFTING	DHBVNL	11 KV	0+920
8	HT Crossing 11 KV (UG)5 Pole shifting+T/F 25kVa	DHBVNL	11 KV	2+150
9	HT Crossing 11 KV (UG) T/F 25KVA+ 1 NoS Pole	DHBVNL	11 KV	2.400
10	HT Crossing 11 KV (UG)& 1 POLE SHIFTING	DHBVNL	11 KV	2.800
11	HT Crossing 11 KV (UG)& 1 POLE SHIFTING	DHBVNL	11 KV	3.500
12	HT Crossing 11 KV (UG)& 1 POLE SHIFTING	DHBVNL	11 KV	3.600
13	HT Crossing 11 KV (UG)	DHBVNL	11 KV	4.150
14	HT Crossing 11 KV (UG) & 14 POLE SHIFTING	DHBVNL	11 KV	4.150
15	HT Crossing 11 KV(UG)	DHBVNL	11 KV	5+150
16	LT Crossing (UG)	DHBVNL	440 V	5+800
17	HT Crossing 11 KV(UG) & 3 Nos pole shifting	DHBVNL	11 KV	6+100
18	LT Crossing (UG)+T/F Shifting +7 Pole shifting	DHBVNL	440 V	6+600
19	HT Crossing 11KV(UG)+T/F shifting+2Nos Pole	DHBVNL	11 KV	6+900
20	HT Crossing 11KV(UG)+T/F shifting+4Nos Pole shifting	DHBVNL	11 KV	7+100
21	HT Crossing 11KV(UG)+T/F shifting+2Nos Pole shifting	DHBVNL	11 KV	8+500
22	HT Crossing 11KV(UG)	DHBVNL	11 KV	10+000
23	HT Crossing 11KV(UG) & 4 Nos Pole Shifting	DHBVNL	11 KV	10+900
24	HT line shifting with T/F 11KV(UG) & 4 Nos Pole Shifting	DHBVNL	11 KV	11+200

25	HT crossing 11 kV(UG)	DHBVNL	11 KV	14+050
26	HT crossing 11 kV(UG)	DHBVNL	11 KV	16+400
27	HT crossing 11 kV(UG)+3 POLE SHIFTING	DHBVNL	11 KV	16+500
28	HT crossing 11 kV(UG)+4 POLE SHIFTING	DHBVNL	11 KV	16+700
29	HT Crossing 11 kV(UG)	DHBVNL	11 KV	19450
30	HT Crossing 33 KV (UG)	DHBVNL	33 KV	19450
31	HT Crossing 33 KV (UG)	DHBVNL	33 KV	19520
32	HT Crossing 33 KV (UG)	DHBVNL	33 KV	19525
33	HT Crossing 11 kV(UG)	DHBVNL	11 KV	19+600
34	HT Crossing 33 KV (UG)- DC	DHBVNL	33 KV	19+700
35	HT Crossing 33 KV (UG)- DC	DHBVNL	33 KV	19+710
36	HT Crossing 33 KV (UG)	DHBVNL	33 KV	19+720
37	HT Crossing 33 KV (UG)- DC	DHBVNL	33 KV	19+730
38	HT Crossing 11 kV(UG)	DHBVNL	11 KV	20+220
39	HT Crossing 11 kV(UG) & t/f shifting with 5nos pole	DHBVNL	11 KV	20+300
40	2 Nos. HT Crossing 33 KV (UG) & Approx 800 mtr Shifting 33 KV-DC	DHBVNL	33 KV	20+300 to 21+000
41	HT Crossing 33 KV (UG)- DC	DHBVNL	33 KV	21+000
42	HT Crossing 11 kV(UG) DC	DHBVNL	11 KV	20+500 to 20+700
43	HT Crossing 11 kV(UG)	DHBVNL	11 KV	22+300
44	HT Crossing 11kV(UG) -DC	DHBVNL	11 KV	22+800
45	HT Crossing 11kV(UG)	DHBVNL	11 KV	22+900
46	HT Crossing 11kV(UG)	DHBVNL	11 KV	22+400
47	HT Crossing 11kV(UG) & 3 nos pole shifting	DHBVNL	11 KV	22+420
48	HT Crossing 11 kV(UG)	DHBVNL	11 KV	28+900
49	LT Crossing (UG)	DHBVNL	440 V	28+920
50	LT Crossing (UG)	DHBVNL	440 V	28+960
51	HT Crossing 11 kV(UG)	DHBVNL	11 KV	29+500
52	HT Crossing 11 kV(UG)	DHBVNL	11 KV	29+500
53	HT Crossing 11 kV(UG)	DHBVNL	11 KV	29+700
54	HT Line shifting	DHBVNL	11 KV	30+200
55	HT Crossing 11 kV(UG)	DHBVNL	11 KV	30+300
56	HT Crossing 11 kV(UG)	DHBVNL	11 KV	30+500
57	LT Crossing (UG)	DHBVNL	440 V	30+520
58	HT Crossing 11 kV(UG)	DHBVNL	11 KV	30+900
59	HT Line shifting with Transformer	DHBVNL	11 KV	31+000
60	2 Nos. HT Crossing 33 KV (UG) & Approx 800 mtr Shifting 33 KV-DC	DHBVNL	33 KV	31+000 & 0+600
61	HT Crossing 33 KV (Ug)	DHBVNL	33 KV	31+010
62	LT Line Crossing Underground	DHBVNL	440 V	0+820
63	LT Line Crossing Underground	DHBVNL	440 V	1+400
64	HT Crossing 11 KV (Ug)	DHBVNL	11 KV	1+550
65	LT Overhead Line With 2 Nos Pole	DHBVNL	440 V	1+900
66	LT Line Crossing Underground	DHBVNL	440 V	2+180
67	LT Line Crossing Underground	DHBVNL	440 V	2+260
68	HT Line 11 KV Overhead With 4 Nos Pole	DHBVNL	11 KV	2+300
69	LT Line Crossing Underground	DHBVNL	440 V	2+470
70	HT Crossing 11 KV (Ug)& Shifting 63 KVa T/F	DHBVNL	11 KV	3+200

71	HT Crossing 11 KV (UG)	DHBVNL	11 KV	3+300
72	LT Crossing (UG)	DHBVNL	440 V	31+020
73	LT Crossing (UG)	DHBVNL	440 V	31+150
74	LT Crossing (UG)	DHBVNL	440 V	31+550
75	LT Crossing (UG)	DHBVNL	440 V	31+800
76	HT Crossing 11 kV(UG)	DHBVNL	11 KV	32+500
77	HT Crossing 11 kV(UG)	DHBVNL	11 KV	32+520
78	HT Crossing 11 kV(UG)	DHBVNL	11 KV	33+450
79	HT Line shifting with 2 Nos Transformer	DHBVNL	11 KV	33+600
80	HT Crossing 11 kV(UG)	DHBVNL	11 KV	33+800
81	LT Crossing (UG)	DHBVNL	440 V	33+880
82	HT Crossing 11 kV(UG)	DHBVNL	11 KV	34+100
83	HT Crossing 11 kV(UG)	DHBVNL	11 KV	34+690
84	HT Crossing 11 kV(UG)	DHBVNL	11 KV	34+700
85	HT Crossing 11 kV (UG)	DHBVNL	11 KV	34+710
86	HT Crossing 11 kV (UG)	DHBVNL	11 KV	34+720
87	HT Crossing 11 kV (UG)	DHBVNL	11 KV	35+550
88	LT Crossing (UG)	DHBVNL	440 V	35+800
89	LT Crossing (UG)	DHBVNL	440 V	36+000
90	LT Crossing (UG)	DHBVNL	440 V	36+500
91	HT Crossing 11 kV(UG)	DHBVNL	11 KV	36+700
92	HT Line shifting with Transformer	DHBVNL	11 KV	36+750
93	HT Shifting with Pole	DHBVNL	11 KV	37+120
94	LT Crossing (UG)	DHBVNL	440 V	38+100
95	LT Crossing (UG)	DHBVNL	440 V	38+760
96	LT Crossing (UG)	DHBVNL	440 V	38+900
97	HT Line Shifting with Transformer	DHBVNL	11 kV	39+220
98	HT Crossing 11 kV(UG)	DHBVNL	11 KV	39+800
99	HT Crossing 33 KV (UG)	DHBVNL	33 KV	39+820
100	HT Crossing 33 KV (UG)	DHBVNL	33 KV	39+850
101	HT Crossing 11 kV(UG)	DHBVNL	11 KV	39+900
102	LT Crossing (UG)	DHBVNL	440 V	40+000
103	HT Line with Transformer	DHBVNL	11 KV	40+750
104	LT Crossing (UG)	DHBVNL	440 V	41+250
105	LT Crossing (UG)	DHBVNL	440 V	41+830
106	11 kV OH wires with H-Tx in KMP ROW	DHBVNL	11 KV	42+950
107	11 kV OH wires	DHBVNL	11 KV	43+030
108	11 KV OH wires H-Tx for House & Diary	DHBVNL	11 KV	43+150
109	11 KV OH wires crossing	DHBVNL	11 KV	43+150
110	Parallel to Pachgaon Tauru road.	DHBVNL	11 KV	40+320
111	2 Utilities of 11kV side shift with 2 Tx. Shifting	DHBVNL	11 KV	43+350
112		DHBVNL	11 KV	44+070
113		DHBVNL	11 KV	44+700
114	11 KV OH wires crossing	DHBVNL	11 KV	44+700
115	11 KV OH wires H-Tx near Manesar Toll Palza	DHBVNL	11 KV	44+730
116	11 KV OH wires crossing	DHBVNL	11 KV	44+780
117	11 kV OH wires crossing cloverleaf	DHBVNL	11 KV	44+880
118	B/w Cloverleaf & NH-8 Palwal side	DHBVNL	11 KV	45+300
119	11 kV OH wires with H-poles b/w UG Through NH-8 & Cloverleaf Under Pass	DHBVNL	11 KV	45+420

120	11 kV OH wires with H-pole Kmp side Pole on II to NH-8	DHBVNL	11 KV	45+420
121	11 kV OH wires with H-pole Kmp side Pole on II to NH-8	DHBVNL	11 KV	45+540
122	11 kV OH wires 2 H-Pole with 2 Tx	DHBVNL	11 KV	45+600
123	11 kV OH wires	DHBVNL	11 KV	46+550
124	11 kV OH wires	DHBVNL	11 KV	47+150
125	11 kV OH wires	DHBVNL	11 KV	47+300
126	11 kV OH wires	DHBVNL	11 KV	48+300
127	11 KV OH wires crossing near wine shop	DHBVNL	11 KV	50+700
128	11 kV OH wire crossing	DHBVNL	11 KV	52+820
129	11 kV OH wire crossing	DHBVNL	11 KV	53+650
130	LT Crossing (UG)	DHBVNL	11 KV	53+700
131	11 kV OH wire crossing	DHBVNL	11 KV	54+100
132	11 kV OH wire crossing	DHBVNL	11 KV	54+820
133	11 kV OH wire crossing	DHBVNL	11 KV	55+014
134	11 kV OH wire crossing	DHBVNL	11 KV	55+100
135	11 kV OH wire crossing with Transformer shifting near ware house location	DHBVNL	11 KV	2+950
136	LT Crossing (UG)	DHBVNL	440 V	3+380
137	LT Crossing (UG)	DHBVNL	440 V	3+610
138	LT Crossing (UG)	DHBVNL	440 V	3+650
139	11 kV OH wire crossing	DHBVNL	11 KV	55+860
140	11 kV OH wire crossing	DHBVNL	11 KV	55+970
141	11 kV OH wire crossing	DHBVNL	11 KV	56+140
142	LT Crossing (UG)	DHBVNL	440 V	1+600
143	LT Crossing (UG)	DHBVNL	440 V	1+900
144	11 kV OH wire crossing	DHBVNL	11 KV	2+100
145	11 kV OH wire crossing	DHBVNL	11 KV	56+145
146	11 kV OH wire crossing	DHBVNL	11 KV	56+515
147	11 kV OH wire crossing	DHBVNL	11 KV	57+830
148	11 kV OH wire crossing	DHBVNL	11 KV	57+900
149	LT Crossing (UG)	DHBVNL	440 V	1+500
150	LT Crossing (UG)	DHBVNL	440 V	1+670
151	LT Crossing (UG)	DHBVNL	440 V	1+960
152	11 kV OH wire crossing	DHBVNL	11 KV	1+970
153	11 kV OH wire crossing	DHBVNL	11 KV	1+975
154	LT Crossing (UG)	DHBVNL	440 V	2+100
155	11 kV OH wire crossing	DHBVNL	11 KV	3+000
156	LT Crossing (UG)	DHBVNL	440 V	3+430
157	11 kV OH wire crossing	DHBVNL	11 KV	3+450
158	11 kV OH wire crossing	DHBVNL	11 KV	3+550
159	11 kV OH wire crossing	DHBVNL	11 KV	3+700
160	11 kV OH wire crossing	DHBVNL	11 KV	3+940
161	11 kV OH wire crossing	DHBVNL	11 KV	4+230
162	11 kV OH wire crossing	DHBVNL	11 KV	4+240
163	LT Crossing (UG)	DHBVNL	440 V	58+660
164	11 kV OH wire crossing	DHBVNL	11 KV	58+940
165	11 kV OH wire crossing	DHBVNL	11 KV	59+050
166	11 kV OH wire crossing	DHBVNL	11 KV	59+250
167	11 kV OH wire crossing	DHBVNL	11 KV	59+470
168	LT Crossing (UG)	DHBVNL	440 V	59+600
169	11 kV OH wire crossing	DHBVNL	11 KV	59+890
170	11 kV OH wire crossing	DHBVNL	11 KV	59+895

171	11 kV OH wire crossing	DHBVNL	11 KV	60+430
172	11 kV OH wire crossing	DHBVNL	11 KV	60+770
173	11 kV OH wire crossing	DHBVNL	11 KV	61+550
174	11 kV OH wire crossing	DHBVNL	11 KV	61+560
175	11 kV OH wire crossing	UHBVNL	11 KV	72+860
176	11 kV OH wire crossing	UHBVNL	11 KV	73+100
177	33 kV OH wire crossing	UHBVNL	33 KV	73+100
178	33 kV OH wire crossing	UHBVNL	33 KV	73+140
179	11 kV OH wire crossing	UHBVNL	11 KV	73+160
180	11 kV OH wire crossing	UHBVNL	11 KV	73+550
181	11 kV OH wire crossing	UHBVNL	11 KV	73+920
182	11 kV OH wire crossing	UHBVNL	11 KV	73+925
183	11 kV OH wire crossing	UHBVNL	11 KV	75+920
184	11 kV OH wire crossing	UHBVNL	11 KV	75+940
185	33 kV OH wire crossing	UHBVNL	33 KV	77+620
186	33 KV OH wire crossing	UHBVNL	33 KV	77+640
187	11 kV OH wire crossing	UHBVNL	11 KV	84+300
188	11 kV OH wire crossing	UHBVNL	11 KV	84+470
189	11 kV OH wire crossing	UHBVNL	11 KV	84+475
190	11 kV OH wire crossing	UHBVNL	11 KV	84+498
191	11 kV OH wire crossing	UHBVNL	11 KV	84+700
192	11 kV OH wire crossing	UHBVNL	11 KV	88+988
193	11 kV OH wire crossing	UHBVNL	11 KV	89+000
194	33 kV OH wire crossing	UHBVNL	33 KV	89+005
195	33 kV OH wire crossing	UHBVNL	33 KV	89+005
196	11 kV OH wire crossing	UHBVNL	11 KV	80+010
197	11 kV OH wire crossing	UHBVNL	11 KV	92+920
198	11 kV OH wire crossing	UHBVNL	11 KV	92+990
199	33 kV OH wire crossing	UHBVNL	33 KV	93+000
200	33 kV OH wire crossing	UHBVNL	33 KV	93+100
201	11 kV OH wire crossing	UHBVNL	11 KV	94+550
202	11 kV OH wire crossing	UHBVNL	11 KV	96+530
203	33 kV OH wire crossing	UHBVNL	33 KV	97+400
204	33 kV OH wire crossing	UHBVNL	33 KV	97+440
205	11 kV OH wire crossing	UHBVNL	11 KV	97+738
206	11 kV OH wire crossing	UHBVNL	11 KV	97+763
207	11 kV OH wire crossing	UHBVNL	11 KV	97+763
208	11 kV OH wire crossing	UHBVNL	11 KV	98+630
209	11 kV OH wire crossing	UHBVNL	11 KV	98+900
210	11 kV OH wire crossing	UHBVNL	11 KV	98+940
211	11 kV OH wire crossing	UHBVNL	11 KV	98+950
212	11 kV OH wire crossing	UHBVNL	11 KV	104+620
213	33 KV OH wire crossing	UHBVNL	33 KV	106+550
214	33 KV OH wire crossing	UHBVNL	33 KV	110+000
215	11 kV OH wire crossing	UHBVNL	11 KV	110+930
216	11 kV OH wire crossing	UHBVNL	11 KV	111+100
217	11 kV OH wire crossing	UHBVNL	11 KV	113+160
218	33 kV OH wire crossing	UHBVNL	33 KV	112+100
219	33 kV OH wire crossing	UHBVNL	33 KV	112+200
220	11 kV OH wire crossing	UHBVNL	11 KV	115+480
221	11 kV OH wire crossing	UHBVNL	11 KV	115+950
222	11 kV OH wire crossing	UHBVNL	11 KV	116+250
223	11 kV OH wire crossing	UHBVNL	11 KV	116+550
224	33 KV OH wire crossing	UHBVNL	33 KV	119+100
225	33 KV OH wire crossing	UHBVNL	33 KV	119+130
226	11 kV OH wire crossing	UHBVNL	11 KV	120+680
227	11 kV OH wire crossing	UHBVNL	11 KV	120+780

228	33 KV OH wire crossing	UHBVNL	33 KV	122+172
229	33 KV OH wire crossing	UHBVNL	33 KV	122+200
230	11 kV OH wire crossing	UHBVNL	11 KV	122+275
231	11 kV OH wire crossing	UHBVNL	11 KV	122+320
232	11 kV OH wire crossing	UHBVNL	11 KV	122+380
233	11 kV OH wire crossing	UHBVNL	11 KV	123+360
234	33 kV OH wire crossing	UHBVNL	33 KV	123+362
235	33 kV OH wire crossing	UHBVNL	33 KV	123+453
236	11 kV OH wire crossing	UHBVNL	11 KV	123+557

(End of Appendix-12)

APPENDIX-13: SUBCONTRACTOR FOR ROCS SYSTEM

1.1 Upon award of the Contract, the Contractor shall engage Specialist Sub-Contractor for Rigid Overhead Conductor System (ROCS) works. The Contractor shall submit details of Specialist Sub-Contractor proposed to be engaged for ROCS Works for the approval of the Engineer. Specialist Sub-Contractor for ROCS Works shall be engaged within six months of the Commencement Date.

1.2 Specialist Sub-Contractor shall have the experience of Design, Supply, Installation, Testing and Commissioning of 25 kV Rigid Overhead Conductor System (ROCS) in Railways/Metro Rail/RRTS/High Speed Rail Tunnel of minimum length of 2.0 TKM on running line in a single ongoing/completed contract during the last seven years from the last date of submission of Tender.

1.3 The Contractor shall submit copy of experience certificates issued by the Employer (owner of the work) as documentary evidence for meeting the minimum experience requirement for ROCS Works by the Sub-Contractor.

1.4 Upon approval of the Specialist Sub-Contractor by the Engineer, the Contractor shall enter into legally enforceable agreement with the Specialist Sub-Contractor within 60 days of approval of Specialist Sub-Contractor. The agreement must specify the specific role and responsibility of the Specialist Sub-Contractor.

1.5 The copy of the agreement between the Contractor and the Specialist Sub-Contractor shall be submitted to the Engineer.

2. Notwithstanding the approval of Subcontractor for ROCS work by Engineer, the Contractor shall be fully responsible for the ROCS work to be done by Subcontractor and Subcontractor shall have no claims against Engineer/Employer of any kind.

Note: If Contractor is meeting the experience requirement for ROCS works, the Contractor may execute the work after obtaining approval of the Engineer. The Contractor shall submit copy of experience certificates issued by the Employer (owner of the work) as documentary evidence for meeting the minimum experience requirement for ROCS Works for approval.

(End of Appendix-13)

APPENDIX-14: CONTRACTOR'S PERSONNEL

MINIMUM ORGANISATION STRUCTURE REQUIRED & PENALTY FOR NON-DEPLOYMENT

The figures indicated in Table below are the minimum number of Contractor's Personnel required which are to be deployed as per the minimum level of supervision.

S. No.	Designation of Contractor's Personnel	Minimum no. of Contractor's Personnel required	Penalty for Non-deployment per month or part thereof per person
1.	Project Manager / (Contractor's Representative/)	As per Section III, EQC	Rs 4,00,000/-
2.	Deputy Project Manager (OHE)	1	Rs 2,00,000/-
3.	Deputy Project Manager (PSI)	As per Section III, EQC	Rs 2,00,000/-
4.	Senior Design Engineer (OHE)	As per Section III, EQC	Rs 2,50,000/-
5.	Senior Design Engineer (PSI)	1	Rs 2,50,000/-
6.	Planning Engineer	1	Rs 2,50,000/-
7.	Senior Engineer (OHE)	1	
8.	Senior Engineer (ROCS)	1	
9.	Senior Engineer (PSI)	1	
10.	Senior SCADA Engineer	1	
11.	Engineer (OHE)	1	
12.	Engineer (PSI)	1	
13.	Senior Quality Assurance and Quality Control Expert	1	
14.	Procurement Manager	1	
15.	Safety and Health Expert	1	Rs 2,00,000/-
16.	Environmental Expert	1	
17.	RAMS Expert	1	-
18.	Surveyor	2	Rs 1,00,000/-

NOTES: -

i. The Contractor shall deploy resources as per the above-mentioned table. The Contractor shall also confirm to deploy manpower over and above the minimum numbers indicated above, if the work so requires.

ii. The performance of project personnel deployed will be evaluated periodically by the Engineer during the contract period. In case the performance of any of the Contractor's Personnel is not satisfactory, the Contractor shall replace them with good personnel immediately as per directions of the Engineer.

iii. The personnel at Sr.No.1, must be deployed by Commencement Date. Personnel at Sr. No.2, 3, 4,5 & 6 in the above table must be deployed within 30 days of Commencement Date. Personnel at Sr. No.15 & 18 in the above table must be deployed within 90 days of Commencement Date. Non adherence to these provisions shall attract penalty as indicated in the table above.

iv. The resources indicated in table above are for peak requirement. All resources need not be mobilized simultaneously for entire duration of the contract. The Contractor shall mobilize the resources as per the deployment programme approved by the Engineer.

v. In case of non-deployment of contractor's personnel, the penalty shall be imposed as indicated above and deducted from Contractor's running / final bills. The decision of the Engineer in this regard shall be final and binding.

Minimum level of supervision, qualification & experience of Contractor's Personnel shall be as follows:

S. No.	*DESIGNATION*	*QUALIFICATION*	*EXPERIENCE LEVEL*
1.	Deputy Project Manager (OHE)	B. Tech in Electrical Engineering	Minimum total experience of 06 years out of which minimum 03 years in projects of 25kV OHE in Railway/ DFC/ Metro/ RRTS
2.	Deputy Project Manager (PSI)	B. Tech in Electrical Engineering	Minimum total experience of 06 years out of which minimum 03 years in Traction Substation projects of Railway/ DFC/ Metro/ RRTS
3.	Planning Engineer	B. Tech in Electrical Engineering with certification in Primavera software	Minimum total experience of 05 years out of which minimum 02 years in relevant field in planning of Infrastructure projects.
4.	Senior Engineer (OHE)	B. Tech /Diploma in Electrical Engineering	Minimum total experience of 03/05 years out of which minimum 02/03 years (degree/diploma) in Project of 25 kV OHE in Railway/DFC/Metro/RRTS
5.	Senior Engineer (ROCS)	B. Tech /Diploma in Electrical Engineering	Minimum total experience of 03/05 years out of which minimum 01/02 years (degree/diploma) in Project of ROCS in Railway/Metro/ DFC/RRTS.
6.	Senior Engineer (PSI)	B. Tech /Diploma in Electrical Engineering	Minimum total experience of 03/05 years out of which minimum 02/03 years (degree/diploma) in Traction Substations Project of Railway/DFC/ Metro/RRTS
7.	Senior SCADA Engineer	B. Tech /Diploma in Electrical/ Electronics/ Communication Engineering	Minimum total experience of 03/05 years out of which minimum 02/03 years (degree/diploma) in Project of Railway/Metro/ DFC/RRTS.
8.	Engineer (OHE)	B. Tech /Diploma in Electrical Engineering	Minimum total experience of 02/03 years out of which minimum 01/02 years (degree/diploma) in Project of 25 kV OHE in Railway/DFC/Metro/RRTS
9.	Engineer (PSI)	B. Tech /Diploma in Electrical Engineering	Minimum total experience of 02/03 years out of which minimum 01/02 years (degree/diploma) in Traction Substations Project of Railway/DFC/ Metro/RRTS
10.	Senior Quality Assurance and Quality Control Expert	B. Tech / Diploma in Electrical Engineering	Minimum total experience of 05/07 years out of which minimum 02/03 years in Quality Assurance and Control (Field) in Railway/Metro/ DFC/RRTS or Infrastructure Project.
11.	Procurement Manager	B. Tech in Electrical Engineering	Minimum total experience of 05 years out of which minimum 02 years in Electrification Project of Railway/DFC/ Metro/RRTS

S. No.	DESIGNATION	QUALIFICATION	EXPERIENCE LEVEL
12.	Safety and Health Expert	B. Tech / Diploma in Engineering/Science graduate with one-year full time Diploma in Industrial safety or equivalent	Minimum total Experience of 02/03 years with relevant experience of 01/02 years (degree/diploma) in infrastructure projects.
13.	Environmental Expert	B. Tech in Environmental Engineering/ Masters degree in Environmental Engineering/ Environmental Science or equivalent	Minimum total experience of 02 years out of which 01 year of experience of working on environmental aspects in Infrastructure projects.
14.	RAMS Expert	B. Tech in Electrical /Electronics & Communication Engineering	Minimum total experience of 05 years out of which minimum 02 years in RAMS field of Infrastructure projects.
15.	Surveyor	Diploma in Civil Engineering / ITI	Minimum total Experience of 01/02 years (diploma/ITI) in survey work for linear Infrastructure project

NOTE:

1. The Curriculum Vitae (CV) of concerned personnel shall be submitted to the Engineer for consideration. No person mentioned in table above shall be deployed in the project without Engineer's approval. Incomplete submission of CV shall not be considered as submission.
2. Relaxation in qualification / experience can be given by the Engineer in exceptional cases where candidates have got high level of professional competency. Decision of the Engineer in such cases shall be final and binding.

(End of Appendix-14)

APPENDIX-15: KEY DATES

The Key Dates (KD) Schedule for Package SYS-1, from Commencement Date:

Key Date	Days	Prithla to New Harsana Kalan section and connectivity
KD-1	60	(a) Submission of Initial Works Programme with all activities. (b) Submission of preliminary design of OHE/ROCS; TSS, SP/SSP and SCADA.
KD-2	84	(a) Submission and approval of detailed Works Programme and OHE Sectioning Diagram incorporating comments of Engineer. (b) OHE Manesar to New Patli (Sultanpur including complete yard and SP) and New Patli to Patli: Finalisation of LOP/CSD design of OHE.
KD-3	210	(a) Finalisation of GTP & source of Traction transformer & Auto transformer and placement of purchase order. (b) Finalisation of GTP, ITP/QAP and sources of supply of all items of OHE.
KD-4	270	(a) Finalisation of all simulation studies (b) Completion of all surveys, geo-technical investigations, earth resistance report etc, for OHE and PSI works of available formation front. Final pollution study report. (c) OHE Manesar to New Patli to (Sultanpur including complete yard and SP) and New Patli to Patli: completion of OHE Foundation work. (d) TSS Chandla Dungerwas and SSP Manesar, SP sultanpur, SLD, GAD, civil design (land preparation, boundary wall, fencing), earth mat.
KD-5	300	(a) Finalisation of GTP, ITP/QAP and sources of supply of all items of ROCS, PSI & SCADA. (b) OHE Manesar to New Patli (Sultanpur including complete yard and SP) and and New Patli to Patli: Completion of erection work of OHE steel structures, isolators, wiring, droppering, earthing etc. (c) SP Sultanpur completion of structure erection and material erection.
KD-6	400	(a) OHE Manesar to New Patli to (Sultanpur including complete yard and SP) and New Patli to Patli completion of OHE adjustment, earthing and bonding, Tower wagon checking, EIG and Commissioning. (b) OHE Dhulawat to Manesar: completion of foundation and steel structures erection. (c) TSS Chandla Dungerwas and SSP Manesar: completion of land preparation, boundary wall, fencing, earth mat. (d) Finalisation of General Power Supply Diagram (GPSD) with equipment numbering.

KD-7	500	(a) OHE Dhulawat to Manesar: completion of erection work isolators, wiring, droppering, earthing etc. Finalisation of cross feeder design. (b) TSS Chandla Dungerwas and Manesar SSP works: Control room building, equipment foundations, cable trench, water recharge pit, oil soak pit, structure erection, arrival of material at site. (c) SCADA material at site and erection work at OCC.
KD-8	600	(a) OHE Dhulawat to Manesar: Completion of all OHE works and testing and commissioning. (b) Finalisation of Traction Station Working Rules (TSWR). (c) Finalisation of design of all OHE, ROCS, TSS/SP/SSP. (d) TSS Chandla Dungerwas and SSP Manesar works: equipment erection, control cable laying, CRP erection, PFC erection, earthing, yard lighting and Testing and Commissioning. (e) SCADA erection work completion for OHE and TSS/SSP. Testing from OCC.
KD-9	800	(a) OHE Prithla to Dhulawat: Completion of Foundation work. (b) TSS Mandothi and SP Prithla, SP Badsa, SP Harsana Kalan, SP Asaudah and SSP Sohna, SSP Dhulawat, SSP Badli, & SSP Jasaur Kheri: completion of land preparation, fencing, boundary wall, control room building, water recharge pit etc.
KD-10	1100	(a) OHE New Patli to Harsana Kalan: Completion of foundation and mast erection work. (b) OHE Prithla to Dhulawat: Completion of Mast erection, wiring, earthing work etc (c) TSS Mandothi and SP Prithla, SP Badsa, SP Harsana Kalan, SP Asaudah and SSP Sohna, SSP Dhulawat, SSP Badli, & SSP Jasaur Kheri: completion of foundations, structure erection, equipment erection etc. (c) Completion of ROCS (Tunnel-1) work.
KD-11	1300	(a) OHE Prithla to Dhulawat and New Patli to Harsana Kalan along with connectivity: Completion of Testing and Commissioning, EIG and CRS Inspection. (b) TSS Mandothi and SP Prithla, SP Badsa, SP Harsana Kalan, SP Asaudah and SSP Sohna, SSP Dhulawat, SSP Badli, & SSP Jasaur Kheri work: Testing and Commissioning, EIG and CRS Inspection. (c) ROCS (Tunnel 1): Testing and Commissioning, EIG and CRS Inspection. (d) Training of staff.
KD-12	1400	(a) ROCS (Tunnel -2) completion, Testing and Commissioning. (b) Integrated Testing completion from Prithla to Harsana Kalan. (c) Supply of spares, tools & tackles and measuring instruments including Tower Wagon.

(End of Appendix-15)

Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

Contract Package SYS-1: Design, Supply, Installation, Testing & Commissioning of 2x25kV, 50Hz, AC, High Rise Overhead Electrification (OHE), Power Supply System and SCADA in connection with laying of New BG Double Railway Line from Prithla to New Harsana Kalan of Haryana Orbital Rail Corridor (HORC) Project from Km (-)2.14 to Km 125.98 Including Rigid Overhead Conductor System (ROCS) in Tunnel Portion i.e from km 24.850 to km 29.580 and its connectivity to IR/DFC networks at New Prithla, Patli, Sultanpur, Asaudah and New Harsana Kalan including modifications in New Prithla, Sultanpur, Asaudah and New Harsana Kalan Station Yards (approximately 145 RKM and 320 TKM).

Part-2- EMPLOYER'S REQUIREMENTS
SECTION-VII-2,

PARTICULAR SPECIFICATIONS (PS)
2X25KV, AC, TRACTION ELECTRIFICATION AND ASSOCIATED WORKS

Summary

Specific Procurement Notice (SPN)

PART 1 – TENDERING PROCEDURES

Section I - Instructions to Tenderers (ITT)

Section II - Tender Data Sheet (TDS)

Section III -Evaluation and Qualification Criteria

Section IV -Tender Forms

Section V - Eligible Countries

Section VI- Prohibited Practices

PART 2 – EMPLOYERS' REQUIREMENTS

Section VII – Employer's Requirements

Section VII-1 - General Specifications

Section VII-2- Particular Specifications (PS)

Section VII-3 Tender Drawings

Section VII-4 ESHS Manual

PART 3 – CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VIII -General Conditions of Contract (GCC)

Section IX - Particular Conditions of Contract (PCC)

Section X - Contract Forms

TABLE OF CONTENTS

CHAPTER- 1 - INTRODUCTION AND OBJECTIVE

1.1 INTRODUCTION

1.1.1 Haryana Rail Infrastructure Development Corporation Limited (HRIDC) was Incorporated on 22nd August, 2017 as a Joint Venture between Government of Haryana and Ministry of Railways with equity Participation of 51% and 49% respectively. The Haryana Orbital Rail Corridor (HORC) is the project of HRIDC, from Prithla (near Palwal station of Indian Railways) to New Harsana Kalan (near Sonepat station of Indian Railways).

1.1.2 Haryana Orbital Rail Corridor (HORC) route will be Broad Gauge, Double Line, with High Rise Electrification at 2x25 kV, AC, approximately 145 RKM and 320 TKM from Prithla to New Harsana Kalan including connectivity to Indian Railway (IR) and Dedicated Freight Corridor Corporation of India Limited (DFCCIL) stations.

1.1.3 There are 17 New Stations namely Prithla, Silani, Sohna IMT, Dhulawat, Chandla Dungerwas, Panchgaon, Manesar, New Patli, Badsa, Deverkhana, Badli, Mandothi, New Asaudah, Jasaur Kheri, Kharkhoda, Tarakpur and New Harsana Kalan.

1.1.4 Out of 17 stations, 4 are Junction Stations namely Manesar, New Patli, Badsa and Mandothi and are proposed with proper connectivity with IR stations. The Prithla station (HORC) with High Rise OHE is connected by double lines with New Prithala station of DFCCIL with High Rise OHE and also to DFCCIL line at Prithla with single line, New Patli station (HORC) with High Rise OHE is connected by single line with IR Patli station with High Rise OHE at chainage 3.000 km (from Ch 0.000 km at New Patli station). The New Patli station (HORC) with High Rise OHE is connected by single line to Sultanpur station (IR) with High Rise OHE. Sultanpur (IR) station with High Rise OHE is connected by single line to Badsa station with High Rise OHE. Mandothi station (HORC) with High Rise OHE is connected by single line with Asaudah station of IR with normal OHE. The Manesar station (HORC) with High Rise OHE is connected with the Maruti Suzuki factory siding with High Rise OHE and also connected with IR Patli station with High Rise OHE and work is being executed by another agency. The proposed double lines (HORC) will be ending at New Harsana Kalan station. The new Harsana Kalan (HORC) station (with High Rise OHE) shall be connected by double lines with Harsana Kalan station of IR with normal OHE.

1.1.5 The Proposed Corridor between New Prithla – New Harsana Kalan with connectivity is having a total of approx. 145 RKM and 320 TKM. The Section is proposed to be electrified with 2x25 kV, AC, 50 Hz, High Rise OHE. Rigid Overhead Conductor System (ROCS) shall be provided in twin tunnels from km 24.850 to km 29.580 between IMT Sohna and Dhulawat station. There is viaduct between Sohna IMT station and tunnel from km 21.345 to km 24.849.

1.1.6 2X25 kV TSS, SP, SSP and High Rise Over Head Equipment (OHE), Rigid Overhead Conductor System (ROCS) and Supervisory Control and Data Acquisition System(SCADA) have been Proposed. SP at Sultanpur (for double line) and Asaudah (single line) of 1x25 kV configuration and modifications in Harsana Kalan IR SSP along with two 1x25 kV feeders from Harsana Kalan IR SSP to New Harsana Kalan OHE have been proposed.

1.1.7 Electric power supply at 220/132 kV through Transmission lines from SEB Grid Substation to TSS shall be provided.

1.1.8 The HORC entails construction of mostly double-track, High Rise 2x25 kV, 50 Hz, electrified railway lines. The bridges (super structure) and formation will be designed for

32.5 T axle load while the track structure will be designed for 25T axle load and maximum permissible speed shall be 160 kmph. The Haryana Orbital Rail Corridor is planned to cater to double stack containers. Up-gradation of transportation technology, increase in productivity and reduction in unit transportation costs as guiding principles for formulating the project.

1.2 OBJECTIVE

1.2.1 These specifications describe the objectives, guidelines and requirements for the design, manufacture, supply, construction, installation, testing and commissioning of High Rise 2x25kV, 50Hz, AC, Electric Traction System, Power Supply System, Overhead Equipment (OHE) & Rigid Overhead Conductor System(ROCS), Supervisory Control & Data Acquisition (SCADA) System, Single Phase 240V power supply by installing 25kV/240V auxiliary transformers at signal & telecom huts, and stations including other associated works for New Prithla to New Harsana Kalan of the HORC Project. The objective of this Particular Specification (PS) is to provide a safe and reliable Electric Traction System meeting application duty requirements in conformance to relevant standards and requirements, performance benchmarks and Contractor demonstrates to the satisfaction of the Engineer/ Employer through modelling, simulation and design validation that the performance requirements are met by the designed system. Further the specifications is to use good industry practice so as to minimise the accidents, breakdowns due to workmanship/ material failure and incidents during implementation phase of the contract as well as to reduce the same when the electrified section is in use.

1.2.2 The objective of the Specifications to Design & Provide a system that renders a satisfactory life of 30-years. The Traction systems its components installed shall be capable of mid-life up gradation with minimum disruption and be supportable for the installation lifetime.

1.2.3 The objective of the Specifications is to minimize maintenance costs by design and selection of Maintenance friendly System which have high Availability, low Life Cycle Cost (LCC), higher Meantime between Failure (MTBF) and minimum Maintenance Time to Restore (MTTR).

1.2.4 The objective is to select a High Rise 2x25kV Electric Traction System which is easy to install and maintain in the least time possible commensurate with the project aims. To achieve this, the system may be designed on a modular approach such that a generic design is used as far as possible with variations to meet local requirements. The system may be designed in such a way that it can be pre-fabricated and pre-assembled unit and tested away from the site of installation and then delivered to site, installed and commissioned.

1.2.5 The objective of the specifications is to ensure that the environmental impact of the electrification and associated works are minimized.

1.2.6 The objective of the specifications is to minimize energy usage. The requirement is to reduce energy consumption by employing the energy efficient system design and product specification.

(End of Chapter-1)

CHAPTER- 2 - OVERVIEW OF THE PROJECT

2.1 HARYANA ORBITAL RAIL CORRIDOR

2.1.1 HRIDC has developed Haryana Orbital Rail Corridor (HORC) from Palwal to Sonepat in the state of Haryana, bypassing Delhi. It is envisaged that the Haryana Orbital Rail Corridor (HORC) will facilitate the diversion of goods traffic not meant for Delhi region and will help in developing multimodal hubs in National Capital Region (NCR) region of Haryana.

2.1.2 The trains are planned to be hauled by electric locomotives with 3-phase drives and/ or existing electric locomotives of Indian Railways employing up to 12000 HP loco for a single train of 6500T.

2.1.3 The Power Supply Installations, OHE and other associated equipment shall be capable of handling projected traffic as per HORC Train operation Plan.

2.1.4 The HORC will utilize 2X25 kV AT feeding system for HORC Project.

2.1.5 The flexible, regulated polygonal Overhead Equipment (OHE) shall be provided for movement of trains within MMD as per the Indian Railway Standard Schedule of Dimensions (IRSSOD) for Haryana Orbital Rail Corridor at a maximum permissible speed of 160 kmph. In the Tunnel Rigid Overhead Conductor System (ROCS) shall be provided.

2.1.6 There are 17 stations in the section and details are as under:

SN	Station	Chainage (km)
1	Prithla	0.00
2	Silani	10.40
3	Sohna IMT	19.01
4	Dhulawat	32.77
5	Chandla Dungerwas	42.60
6	Panchgaon	46.29
7	Manesar	51.89
8	New Patli	58.00
9	Badsa	64.75
10	Deverkhana	71.14
11	Badli	76.83
12	Mandothi	90.45
13	New Asaudah	94.03
14	Jasaur Kheri	100.22
15	Kharkhoda	108.72
16	Tarakpur	114.20
17	New Harsana Kalan	125.13

Out of 17 stations, 4 are junction stations namely Manesar, New Patli, Badsa & Mandothi and 6 are crossing stations namely Silani, Chandala Dungerwas, Panchgaon, Deverkhana, New Asaudah, and Jasur Khedi.

2.2 POWER SUPPLY FOR THE HARYANA ORBITAL RAIL CORRIDOR

2.2.1 The Proposed corridor between Palwal to Sonepat section is having a total of approx.. 145 RKM and 320 TKM. The Corridor is proposed with 2 Nos Traction Substations (TSS) and Switching Stations (SP-3 nos., SSP- 5 nos) of 2x25 system for power supply to the sections. There shall be 2 nos. SP of 1x25 kV system at Sultanpur (for double line) and Asaudah (for single line) for isolation of supply from IR at connecting locations and feed extension.

2.2.2 The 220/132 kV power supply shall be suitably stepped down at TSS as follows:

(a) For feeding 2X25 kV AT systems for AC traction OHE, this shall be distributed between feeder wire and catenary – contact wires.

(b) For feeding 240 V, single phase A.C. for auxiliary power supply requirements drawn from Traction OHE circuit through Auxiliary Transformer(s).

2.2.3 The 25kV/ 240V Auxiliary Transformers shall be provided for meeting the auxiliary power requirement of switching posts like SP, SSP, SS installation and stations etc. as described in relevant chapters of this Particular Specification.

2.2.4 The power supply shall be monitored and controlled through a Supervisory Control and Data Acquisition (SCADA) system.

2.3 CIVIL (STRUCTURE, TUNNEL, TRACK, BRIDGE), S&T AND Electrical WORK

The Civil structure and Track work has been planned to be assigned to Other Contractors through other than Contract SYS-1 Package. The details of other contractors are as under:

SN	Contract Package	Contractor	Area Chainage km
1	C-5	Civil (without track) and Electrical General	(-)2.11 to 24.40
2	C-4	Civil Tunnel (with track) and Electrical General	24.40 to 29.14
3	C-23	Civil (without track) and Electrical General	29.68 to 49.70 and 55.60 to 61.50
4	C-1	Civil (without track)	49.70 to 55.60
5	C-6	Civil (without track) and Electrical General	61.50 to 125.98
6	T-1	Track	Cover C-1 and C-23 section
7	T-2	Track	Cover C-5 and C-6 section
8	BR-1	Bridge	Pataudi Road at km 54
9	SYS-2	Signalling and Telecommunications	Entire section from Prithla to New Harsana Kalan
10	SYS-1	Electrical (PSI, OHE and SCADA)	Entire section from Prithla to New Harsana Kalan
11	MSIL(OHE)	Electrical (OHE)	MSIL to Manesar station to Patli (IR) station

The power supply in control room buildings of TSSs, SSPs, SPs, other buildings and civil works as covered in PS including E&M and Associated Works (i.e lights, fans, air-conditioners, conduiting, cabling, general lighting, yard lighting etc.) shall be under the scope of this SYS-1 Package.

2.4 INTERFACE MANAGEMENT AND COORDINATION

The contractor shall maintain the required liaison and interface with other contractors for the delivery of the work as described in this specification.

(End of Chapter 2)

CHAPTER 3 - SCOPE OF WORKS

3.1 GENERAL

3.1.1 The Scope of Work under the Contract as described in this Particular Specification (PS) shall include conducting Traction system simulation study, Detailed design, supply, manufacture, construction, Installation, Testing & Commissioning including the technical support, trial runs & integrated testing. for a complete system necessary to provide Traction power supply from 220/132kV / 2x25kV Traction Power Supply System, AT feed system, High Rise Over Head contact line Equipment (OHE) & ROCS (Rigid Overhead Conductor System) complete with Supervisory Control and Data Acquisition (SCADA) system and associated works for Prithla to New Harsana Kalan section of HORC as under but not limited to:

(1) Study the Employer's requirement, conduct Surveys/Studies, assess site requirement and prepare System's Requirement Specifications (SRS) as compiled from this PS, GS, Standards and other Contract documents.

(2) Configure Traction system and major components, System architecture, Scheme Designs with Work Breakdown Schedules (WBS) of activities as per the Guidelines/Best practices describing the technology and range of the products with evidence on satisfactory and proven performance;

(3) Operational & Performance requirement, traffic scenarios and assessing Traction power requirement;

(4) Conduct Traction Simulation Study for identified train operation plan of the section to determine the sizes of Power supply and Overhead equipment.

(5) 25 kV High Rise Rigid Over Head Conductor system (ROCS) for Twin Tunnels.

(6) Preliminary, Detailed Designs and Drawings supported by calculations, reports, Quantity take off sheets, references and RAMS bench marks;

(7) Preparation of requisite Technical Specifications & Schedule of Guaranteed Performance (SOGP) as required for procurement, Manufacture, supply, construction, installation, testing, trials and integrated testing & commissioning;

(8) Assurance of System Safety, RAMS and Environmental requirement and Verification & Validation of Reliability performance;

(9) Technical support for Execution, Supervision of work, Quality Assurance, Site Safety, Health & environment (SHE);

(10) Interfaces with other associated sub systems such as Rolling Stock, Signalling & Train Control, Telecommunication system, Track systems, Depot, stations and Civil Infrastructure etc.,

(11) Testing & commissioning of 2x25 kV AC Traction system and associated works.

(12) Training of Employer's personnel;

(13) Supply of spares, T&P and other equipment as specified for Operation & Maintenance.

(14) Comprehensive maintenance of entire works under this PS for a period of 3 (three) years from the date of taking of works by Employer. Contractor shall develop daily, weekly, monthly, six-monthly, and yearly maintenance schedules and also for periodical overhaul. During this period, all material, tool and tackles, consumables and manpower shall be provided by Contractor. The Maintenance shall be

undertaken as per guidelines of RDSO, ACTM and Manufacturer's maintenance manuals. The various maintenance schedule i.e daily, weekly, monthly, quarterly, half yearly, yearly and periodic overhaul etc of all equipment of OHE, ROCS, TSS/SSP/SP and SCADA system along with associated works shall be submitted by Contractor for approval of Engineer. The details are in Chapter 20 of PS.

3.1.2 The scope shall include provision of any/ all necessary /additional equipment, equipment of higher capacities and higher ratings for the systems and sub-systems necessary forthe complete, safe, reliable, operable and maintainable Electric traction power supply system for the HORC Project.

3.1.3 The scope of work shall include any other associated Works related to satisfactory completion of the Work as defined above and under this specification.

3.2 DESIGN BY COMPUTER SIMULATION

3.2.1 The capacities, ratings and numbers of equipment as proposed by the Contractor as a basic requirement of Design Development shall be determined and demonstrated by a proper Design Calculation & Traction Simulation Study and shall be got approved from the Engineer, The averaging period assumed for determining size of major equipment shall be as per EN: 50388 as applicable.

3.2.2 The Contractor shall examine and ensure through Computer based traction power simulations and EMC/EMI etc that the Indicative minimum capacities, ratings, quantities of equipment and locations as specified herein meet the operational requirement for Prithla to New Harsana Kalan section. Otherwise, contractor shall adopt the higher capacities, ratings and quantities as per the results of simulation study conducted by the contractor with the approval of the Engineer. The ratings, capacities etc. given in the PS are minimum only and shall be provided. If higher capacity rating equipments are required as per simulation studies, then higher capacity rating equipments shall be provided.

3.2.3 It shall be the responsibility of the contractor to assess, calculate and propose capacities, ratings, number/quantity and locations of equipment considering Normal/ Possible power Failure and short circuit and stringent application duty and Operational Requirements for Prithla to New Harsana Kalan section as an essential requirement of the design development.

3.2.4 The Contractor shall undertake multi train traction power simulations for the entire Prithla —New Harsana Kalan section using a proven and fully validated computer based Multi Train Simulation Software. The simulation study shall model normal operations and extended feed Scenarios over feeding zone. The simulation study shall include as below but not limited to:

(1) Traction Simulation Study: Traction Power Load Flow and Short Circuit study;

(2) Short time Over load, Short Circuit Current in Normal and extended feed Scenarios over complete feeding zone;

(3) The determination of sizes of the Power Supply Equipment, Traction Transformer(s), Autotransformer, CB, CT and Bus bar system etc. under Normal, Emergency feed condition and fault scenarios;

(4) The determination of sizes of all conductors / wires etc. under Normal, Emergency feed condition and fault scenarios within permissible Temperature rise limit in conductors like Contact wire, Catenary, Traction & Negative feeder, jumpers,

AEWand BEC (if required);

(5) Optimum Voltage Regulation / Voltage drop at SSP / SP or adjacent TSS, the farthest end for stringent possible scenario (N-1);

(6) Voltage imbalance and THD imposed at Point of Common Coupling (PCC) with power supply authorities at normal rated capacity as well as extended feed scenario in full load conditions and mitigation measures thereof including sizing of mitigation equipment;

(7) EMI/EMC study;

(8) Induced EMF on the Signalling &Telecomm and other utilities in proximity;
Rail accessible and Touch Potential within safe limits under Normal & Fault Conditions including configuring earthing and bonding for the entire system (including those on adjacent structure and IR lines running parallel to HORC alignment); determination of sizes / Intervals of interconnection between AEW & BEC (if required) and their connection to mast/earth-station and rail without any compromise in safety of public/ Railway maintenance personnel even in case of OHE Short Circuit Fault while ongoing discontinuity in rail track system due to hair crack(s) as well as discontinuity in AEW;

(1) Step and Touch potential rise in TSS, SSP, SP, SS and ATs including Earthing Calculations;

(2) Insulation Coordination Study;

(9) Catenary-Pantograph Dynamic Interaction (CPDI) study etc.: Technical criteria for the interaction between pantograph and overhead contact line are stipulated in EN 50367 and EN 50119.

(10) ROCS design validation by simulation study to ensure that ROCS design meet the maximum permissible speed.

3.2.5 Computer Simulation Analysis and Reporting

The contractor shall undertake a Computer Simulation Analysis for Prithla to New Harsana Kalan section for the following train operations:

1: Total Freight Traffic in the Horizon years

Financial year	Tonnage in Million Tonnes (MMTPA)	Trains per day
2025	54	48
2027	67	59
2032	81	72
2037	89	81
2042	100	93
2047	115	108
2052	134	128

2: Total passenger traffic along the project corridor

SN	Year	UP (Palwal to Harsana Kalan)	DN (Harsana Kalan to	Total

			Palwal)	
1	2025	9	9	18
2	2027	10	10	20
3	2032	11	11	22
4	2037	12	12	24
5	2042	13	13	26
6	2047	14	14	28
7	2052	15	15	30

(A) Simulation -1

Normal feeding arrangement as defined in Clause 5.1.4 of Chapter 5 of this PS.

(B) Simulation -2

Emergency Feeding Arrangement- First Failure Condition as defined in Clause 5.1.5 of Chapter 5 of this PS.

3.2.6 Computer Simulation Analysis Output/ Results

The Contractor shall provide the Simulation Results in the form of Simulation Reports for each Computer Simulation Analysis.

3.3 SCOPE

3.3.1 The Scope of Work shall include design, supply, manufacture, construction, Installation, Testing & Commissioning of Traction power supply system, AT feed system, High Rise Over Head contact line Equipment (OHE) with ROCS in tunnel and Supervisory Control and Data Acquisition system and associated works for Prithila to New Harsana Kalan of HORC and connections to IR/DFCCIL lines as under but not limited to:

(1) Configuration of traction power supply system

Indicative General Arrangement Diagram (GAD) for Traction Power Supply System and Power Supply Installations are shown in the General Supply Diagram. The configuration of traction power supply system as required shall comprise of the following but not limited to:

(i) Traction equipment, Traction Transformers, Auto transformers as required and Bus bars suitably designed/ capable to feed the extended feed zone as per application duty requirement;

(ii) Control & Protection system and Circuit Breakers etc. as required to automatically isolate faulty section/ equipment;

(iii) Traction Power Return current, Earthing & Lightning protection etc.

(iv) Power Quality Monitoring, Controlling Devices and other equipment and provisions as described in the PS to improve power quality, and keep harmonics and voltage unbalance within the specified limits at rated Capacity or as specified in this specification;

(v) Provision of Traction substations (TSS), Sub Sectioning Posts (SSP) and Sectioning Posts (SP), Switching Stations (SS) and ATs as described in relevant Chapters of this specification and as under:

a. Traction Substations (TSS)

Provision of 2(Two) Traction Sub Stations(TSS) for traction power supply to 2x25kV AT feeding system with double circuit 220/132 kV supply tapped for each TSS. Typical indicative TSS arrangement is enclosed in Part 2, Section VII, Volume 3. The provisions at TSSs shall include the gantry for termination of 220/132 kV Line and associated switchgears along with SCADA interface as required shall be executed by the contractor.

b. Five (5) Sectioning Posts (SP).

c. Five (5) Sub Sectioning Posts (SSP).

d. Auto-transformers shall be provided at each TSS, SP and SSP (as required as per design). There shall not be provision of any spare AT at TSS, SP & SSP.

(2) **Supervisory Control & Data Acquisition** (**SCADA**)

(a) The Integrated Operation Control Center (OCC) for Haryana Orbital Rail Corridor (Package SYS-1) has been planned at Manesar. The provision of SCADA equipment for Traction SCADA required at the OCC level for the entire the field equipment i.e RTU, Hardware interface and cable/Channel etc. shall be designed and executed from Prithila to New Harsana Kalan Section with connectivity at IR/DFCCIL under the Scope of the Contract. As described in relevant chapters of this PS, including the provisions for interlocking / interface arrangement with the SCADA system (SYS-1) Indian Railways and Power Supply Authority.

(b) The 25 kV OHE work along with SCADA of Maruti Suzuki India Limited (MSIL) factory to Patli station of IR along with one additional SP at Patli station of IR is being undertaken by Contractor – MSIL(OHE). The OCC equipment for this line and additional SP shall be under the scope of this Package-SYS-1. Necessary interface with Northern Railway and Contractor-MSIL(OHE) shall be made by the Contractor SYS-1.

(c) There will be connection of HORC line with IR i.e (1) from New Patli station to Sultanpur station (IR) and Sultanpur station (IR) to Badsa with SP at Sultanpur station (IR); (2) from Mandothi station to Asaudah station of IR with SP at Asaudah station (IR) and (3) New Harsana Kalan to Harsana Kalan station (IR) with SP at New Harsana Kalan station. Being boundary posts, the control and status of SCADA shall also be required at Northern Railway Remote Control Centre (RCC). The entire SCADA work shall be under the scope of Contractor – SYS-1. Necessary interface with Northern Railway (NR) for equipment provision and software upgradation at OCC/RCC (Remote Control Centre) of NR shall be done by the Contractor.

(d) There shall be modifications in Harsana Kalan IR SSP along with SCADA and two 1x25 kV feeders from Harsana Kalan IR SSP to New Harsana Kalan OHE shall be provided. Necessary interface with Northern Railway (NR) shall be done by the Contractor for these works.

(e) The HORC both lines at Pirthla station shall be connected to New Pirthla station of DFCCIL and Prithla SP shall be provided cbetween Prithla station of HORC and New Prithla station of DFCCIL. Prithla SP shall be boundary post and hence, necessary interaction with DFCCIL shall be done by the Contractor-SYS-1 for control and status monitoring and equipment provision at DFCCIL OCC. The HORC line at Prithla shall be connected to DFCCIL line by single line at Prithla.

(3) **240V, single phase, A.C. Auxiliary power Supply**.

i. 240 V A.C. single phase, Low Voltage (LV), Auxiliary Power Supply shall be drawn from 25 kV Traction circuit through 2 nos. 100 kVA Auxiliary Transformers at TSS including all terminations and cabling.

ii 240 V A.C. single phase, Low Voltage (LV), Auxiliary Power Supply shall be drawn from 25 kV Traction circuit through 2 nos. 25 kVA Auxiliary Transformers at all Power Supply Control Posts i.e. SPs and SSPs including all terminations and cabling.

iii 240V AC, single phase, LV, Auxiliary Power Supply for other users from 25kV OHE Power Distribution System shall be provided for Signal & Telecom installations and Station Operations along the entire route with redundancies and Automatic Source Transfer / Automatic Change Over (ACO) system as required and as given below :

1. Signal & Telecom Equipment Room(s) along the entire route (if required);
2. Crossing stations;
3. LC Gate(s);

iv At 4 junction stations i.e Manesar, New Patli, Badsa & Mandothi and four other stations i.e Prithla, Sohna IMT, Kharkhoda & New Harsana Kalan, 2 nos. 50 kVA auxiliary transformers with ACO Panel at each station shall be provided. At other stations 2 nos. 25 kVA auxiliary transformers at each station shall be provided with ACO panel. At Level Crossing (LC) Gate(s) (if any), 2 nos. 10 kVA auxiliary transformers shall be provided.

v. The LT cable used for connection between 240 V AC supply from Auxiliary Transformer to Auto source transfer switch (ASTS) i.e ACO Panel shall be minimum 2 Core 70 sqmm copper conductor, XLPE insulated armoured cable. The total voltage from the LT source (Auxiliary transformer LT to the farthest end use shall not exceed 5%.

(4) **Execution of Cables, Cable containment system and feeder network** including the following:

a. 25 kV AC cable/ overhead connections from TSSs/ SPs/ SSPs/ SS /ATs (as required) to OHE.

b. Return current cabling and bonding along the alignment and in yards;

c. Auto Transformer connections to the rails;

d. All connections for traction Rail bonding;

e. Any other cable and Cable terminations etc.as required of appropriate ratings.

(5) **2x25kV AT Feed Overhead Equipment (OHE)**

The OHE system configuration as required shall comprise of the following but notlimited to:

a. 2x25kV AT Feed Overhead Equipment (OHE) on main lines; comprising Traction & Negative Feeders, Catenary & contact wires;

b. 1x25 kV system for loop lines and yard lines;

c. 1x25 kV system for the connecting lines to Indian Railways upto IR meeting point as per Interface plan with IR and with DFCCIL;

d. Aerial Earth Wire (AEW);

e. Buried Earth Conductor (BEC, if required);

f. Protective screen over catenary and NFW at foot over bridges (FOB) at Harsana Kalan station (if any) along with warning & danger boards with earthing.

(6) 2x25 kV Overhead Equipment (OHE) and ROCS

(i) 2x25 kV, 50Hz, AC Electrifications with High Rise OHE system as per guidelines /Specifications/standard issued by RDSO/CORE/Railway Board.

(ii) 2x25 kV, 50 Hz, AC Electrification with Traction High Rise Overhead Equipment for HORC Sections in tunnels, Viaduct Mast on Elevated section and Bridge Mast and Anchor on Bridge Piers.

(iii) Modifications to existing OHE, feeder wires including dismantling of OHE, feeders, removal of Brackets, cutting mast/portal below 150 mm from ground level (including breakage of foundation below 150 mm from ground level to avoid any hindrance). removal of existing auxiliary transformer. The modifications in IR OHE shall be required Sultanpur, Asaudah and Harsana Kalan stations and all released material of these modifications shall be returned to IR.

(iv) Modifications to existing DFCCIL OHE, feeder wires including dismantling of OHE, feeders, removal of Brackets, cutting mast/portal below 150 mm from ground level (including breakage of foundation below 150 mm from ground level to avoid any hindrance). removal of existing auxiliary transformer etc at New Prithla (DFCCIL station) and Prithla (DFCCIL Lines). All the released material of these modifications shall be returned to DFCCIL.

(v) High Rise 2x25 kV Rigid Over Head Conductor System (ROCS) for Tunnel, Transition arrangement of ROCS to 2x25 kV OHE at entrance and exit portion of twin tunnels.

(7) Earthing and Bonding plans shall be prepared and implemented as required for Prithla to New Harsana Kalan section and adjacent Indian Railway tracks or any other Utilities or metallic structures in proximity belonging to other independent authorities to provide protective provisions against EMI from 25kV traction currents and to limit step and touch potentials as a result of Simulation study. The Simulation study shall include twin tunnels also. The earthing Simulation Study shall be got conducted by Contractor from a third party who have experience of at least 3 Railway/Metro/MRTS projects in last 5 years. The third party shall use generic software (shall not use their own software) and the software should have been used in at least 5 Railway/Metro/MRTS projects in last 5 years and proof of the same shall be submitted..

(8) Protective measures to mitigate EMI/ EMC interference shall be implemented based on the results of traction simulation study and EMC/EMI study conducted by the contractor and as reviewed and accepted by The Engineer. Protective provisions would include provision of Aerial Earth Wire (AEW) mounted on masts with earth connections at regular intervals including connection at requisite intervals to Buried Earth Conductors (BEC, if required) to provide an energy efficient/lowresistance return current path, minimise the impact of the interference,

the inducedvoltage on utilities along the track and to limit the rail potential rise in conformance to relevant standards. The BEC (if required) shall be capable to handle the Return current as may be witnessed during the broken rail or Rail Maintenance without raising the touch potential beyond acceptable limit and compromise the safety of General public or Rail personnel in proximity/ touch. The rail conductor system network (comprising contact, catenary, Negative feeder, AEW, BEC (if required) and rails shall be modelled to demonstrate that the potential rise in all possible OHE/Power fault case scenarios remains lower than the permissible limit at any point as per relevant standards including step and touch potential while on going discontinuity in Rails unnoticed like hair cracks etc. and discontinuity of AEW due to failure/theft if any in two independent systems.

(9) **Electrical safety and Clearances**

a. Provisions for electrical safety i.e. Rubber mats, First aid boxes, Personal Protective Equipment (PPE) like, Goggles, Gloves, Helmets, eyewash kits, danger plates, fire-fighting equipment. Shock treatment Charts, Signage, caution boards, labels and notices in adequate number shall be exhibited at conspicuous locations being statutory requirement.

b. Working and Electrical clearances more than or equal to the prescribed minimum clearances as identified in National Electric Code (NEC) or NFPA-70 or prescribed by RDSO/CORE/IR/ACTM, whichever is higher.

c. Insulation over catenary and Feeder wire under all the Bridges, FOBs, ROBs and Over-line structures. The Insulation level of the insulating sleevesconsidered, if any shall conform to EN50124-1.

(10) All civil works or modifications required for installation of the equipment and restoring to final finishes by the contractor shall include but not limited to:

a. Survey, ground investigation, soil resistivity, and hydrological studies of the site and consider for the design and Implementation including the sharing of the Video-graphic evidences of natural soil/ land levels with the Engineer.

b. Construction of Control Room Building at TSS, SSP, SP and Tower Wagon Shed etc. meeting the functional and technical requirement with required clearances and safety provisions as required. Provision of GI concealed conduits, wiring, fans, lights, air-conditioners (if required), outside lighting system.

c. Preparation and levelling of ground required for the work including earth filling for TSS / SSP / SP and other buildings constructed under this Contract Package and to lift the land to obtain the Finished Ground Level (FGL) within the Right of Way (ROW) for traction power installations. Earth compaction to be more than 95%.

d. Spreading of Gravels in the TSSs, SPs, SSPs and other places as required.

e. The Cable containment system and RCC trenches with modular trench covers, with metallic frame for ease of manual lifting; as approved by the Engineer.

f Construction of road(s) and pavements within power supply installations suitable for movement of heavy equipment, Construction of Boundary wall/ fences, drainage and sewerage, rain water harvesting pits.

g. Construction of foundations for traction equipment / component and containments, Equipment mounting structures, OHE Masts, Portals and

Gantries etc.

(11)

(1) **'Mandatory Spares', special tools, testing and diagnostic equipment and measuring instruments** as described in relevant chapter shall be supplied at least 6 weeks before the revenue operation. The contractor shall also provide the List of 'Recommended Spares as prescribed by the Manufacturer' mentioning the Price of all such recommended Spares, which, if Employer wants, can procure. All kinds of Consumable materials not limited to printer cartridges, tapes and papers etc. shall be supplied by the contractor for the period up to the handing over of the work to the Employer. The spares consumed/ utilised by the Contractor during the Defect Notification Period shall be made good by the contractor.

(2) The Electric Traction system designs shall be interfaced & coordinated with the civil infrastructure design with regards to site access control; fencing; paving; drainage; access roads; earthing system (earth resistivity); cables, under track/ through crossings, between traction power substations, Switching Stations and signalling, traction power substations and the Power Supply authority Indian Railway's Transmission Line Network.

3.3.2 Services

The Services to be performed by the Contractor shall include, but not be limited to, the following:

(a) Ground Investigation, hydrological survey and report thereof before Preliminary Designs including identification of locations and construction of foundations for OHE equipment and for other equipment in TSS, SSP, SP, and ATs.

(b) Preparation & implementation of Work Program and Management Plans as given in GS.

(c) Study of Employer's Specifications & Deliverables, preparation of SRS and Verification & Validation (V&V) Criterion.

(d) Preparation of Scheme/ Preliminary Design with Equipment layouts & Drawings, performance Parameters, Detailed design**,** calculations, studies and drawings.

(e) Preparation of Technical Specifications and Schedule of Guaranteed Performance (SOGP) Particulars for system equipment,

(f) Proposals on makes of material in required Format as prescribed with evidences on conformance for approval of the Engineer.

(g) Procurement/ Supply, construction, system quality Assurance, installation, Inspections, testing and commissioning of the complete traction system

(h) Organising & witnessing of Prototype and Factory Acceptance Testing as per test plan and Stand-alone tests of the Power Supply System, OHE ,ROCS and SCADA system/ subsystem/ equipment etc.;

(i) Presentations, reviews and audit support as specified in this Specifications.

(j) Interface management

The contractor shall develop the Electric Traction System with key interface requirements with other sub-systems requirements and deploy the competent professionals for the management of Interfaces and Integration with other systems/ contractors.

(k) Taking possession/access of the site, execution of the work and return/handing over.

(l) Trial runs and integrated testing &commissioning with other systems like track, Signalling & Telecom and Rolling stock.

(m) Training for Employer's personnel.

(n) Decommissioning, removal and/or disposal of temporary works.

(o) Obtaining statutory clearances including preparation of Documentation and submission of information asked for by statutory bodies e.g. Government of India, Ministry of Railways, Commissioner of Railway Safety, and Electrical Inspector to Govt. of India (EIG), Government of Haryana including fees, if any, to be borne by the contractor as directed by the Engineer.

(p) EMC Management including twin tunnels.

(q) Earthing & Bonding Management including twin tunnels.

(r) Taking Power Blocks and Permit to Work for the execution of new work under the scope as required, including that for modification and dismantling involved.

(s) Global Positioning System (GPS) Mapping of all the OHE masts/ portals, feeders of Entire OHE section to get X, Y & *Z* Coordinates for each mast location using best accuracy rendering GPS method as approved by the Engineer. The Mapping data shall be submitted by the Contractor in hard as well as in Soft copy to the Engineer for approval.

(t) Service during Defect Notification Period;

3.3.3 Documentation

The documentation to be delivered by the Contractor shall include but not limited to the following:

(1) Following documents, shall be prepared and got approved from the Engineer (who shall obtain consent of Employer): -

(a) Design Manual including Verification and Validation and Design Checklists,

(b) Simulation Studies & results for traction power study, and EMC/EMI including Input data & assumptions Reports, graphs and recommendation thereof along with supportive Explanatory Reports/ notes/ documents and any information required by The Engineer,

(c) EMC/EMI Control & Management Plan,

(d) Earthing and Bonding Management Plan,

(e) General Traction Power Supply Diagram and Sectioning Diagram

(f) Pollution Mapping of the section,

(g) Protection system scheme with relay coordination and Calculations,

(h) SCADA System documents,

(i) Interface Management Plan,

(j) Test Plans and reports as described in relevant chapter. Power Quality Study Report including the possible power correction methods with harmonic suppression.

(k) Installation Plan, Testing and commissioning plan.

(l) Technical Specifications for Power Supply System, OHE and SCADA System etc. to be drawn by the contractor, based on functional specifications for the items proposed to be used for the first time on Indian Railways.

(m) Demonstration results of Fault Simulation and Fault Localisation at locationsas desired by the Engineer.

(n) Method statements, Work Plan, Quality assurance, Safety plans including site safety etc. as specified in GS.

(2) Following documents shall be approved by the Employer to be submitted through the Engineer:

(a) Training plan;

(b) Operation and Maintenance plan.

(3) The documents to be delivered by the contractor shall include but not be limited to,the following:

(a) Preliminary Design Stage

(i) Inception report including

a. Understanding of Project, Scope of Work, mobilisation of resources/ office/ Organisation/ qualified design team/Key personnel, describe Approach & Methodology for design & execution and Concept Schemes of 2x25kV AT Feeding System, OHE, ROCS, Scheme of Power Supply, Power Supply equipment i.e. traction transformer(s), Auto transformers, ratings of the switchgear CT, PT, Protection scheme, SCADA System, OHE arrangement and conductors & their fittings etc.

b. Initial work Program,

c. Study of Employers' PS, GS, relevant standards, Employer's schemes/ Drawings and other contract documents and preparing System Requirement Specifications (SRS), Verification and Validation Criteria,

d. Strategy on RAMS and EMC Compliance,

e. Design manual describing design philosophy, Design Quality assurance, Design Verification checklists etc. planned to be adopted to deliver a safe and reliable Traction system.

(ii) Simulation Studies Results reports and calculations.

(iii) Preliminary Design

a. Preliminary design including power supply diagram, sectioning diagram, SCADA and Traction system architecture

b. Assessment of possible power failure scenarios, Normal and Peak current requirement under failure and Power supply configuration under such failure scenarios and the Power / peak current requirement;

c. Calculations on Sizing of all Power Supply Equipment and conductors but not limited to :sizing of Jumpers, droppers, Cantilevers, Masts, foundations, conductor sag, Auto tensioning devices, OHE mechanical loading Calculations /Selection of OHE masts, ROCS, foundation design, feeder cables, Cable containments, Sizing of CB, CT, Bus bar and other provisions thereof;

d Earthing and Earth Mat calculation with Step and Touch potential at TSS, SSP, SP and AT as per IEEE80- 2013;

e TSS, SSP and SP Equipment layouts suitable to Land size and shape;

f Report on Design of protection systems including Lightning / Surge protection measures;

g Proposed design & calculations of Power Quality correction equipment and harmonic suppression;

h Electrical Clearance Study Report;

I Documents for the items/ equipment not covered by RDSO specifications requiring Cross Acceptance.

(iv) Preliminary Design Report with Definitive Scheme design, Configuration of Electric Traction System, Power Supply installations, Equipment capacities/ Ratings, OHE/ROCS Installations, OHE Conductors & sizes, ROCS item sizes as confirmed by simulation study, Insulation Coordination study Report, Clearance study report, schemes and Arrangement Drawings, SCADA System, Strategy to Integrate with the IR Network Interface, Management Plan, Design submission Program.

(b) Detailed Design Stage

(i) Final Design Scheme as concluded after the Preliminary design approval and observations thereon by the Engineer on Preliminary Design;

(ii) Detailed Design Calculations of equipment and components as required;

(iii) Evidences of the design compliance on simulation results;

(iv) Technical Specifications (TS) to be drawn by the contractor based on functional specifications particularly for the items proposed to be usedfor the first time on Indian Railways. The Contractor shall use the Technical specification of RDSO where available. The TS prepared by the Contractor shall be generally in the format of RDSO Specifications;

(v) Schedule of Guaranteed Performance (SOGP) Matrix;

(vi) Detailed design Drawings;

(vii) Design Reports complete with Executive summary, Methodology, Relevant standards, assumptions, Input data, Calculations, Study results and Recommendations;

(viii) Study reports as relevant to conclude the designs;

(ix) Detailed interface reports and Detailed interface Design/ Drawings(DID);

(x) Hazard identification, Preliminary Hazard Analysis (PHA), Hazard Logand Mitigation documentation and Hazard operability;

(xi) Earth Resistivity Measurement;

(xii) Detailed EMC/EMI control &management plan;

(xiii) Detailed Earthing and bonding plan;

(xiv) Protective system proposed along with automatic fault locator (AFL) with its suitable algorithm to isolate the faulty section on OHE and feeder with high degree of accuracy;

(xv) Pollution mapping for identification of polluted zones warranting useof longer Creepage path insulators;

(xvi) System Reliability, Availability, Maintainability and Safety Assessmentreports (RAMS);

(xvii) Systems integration plan and proposed Integrated testing & commissioning;

(xviii) Training Plan;

(xix) Operation &Maintenance Plan;

(xx) Equipment, conductor & fitting specifications and their Schedule of Guaranteed Technical Performance (SOGP).

(c) Construction & Installation Stage

(i) Work Plan;

(ii) Procurement Plan;

(iii) "Quality Assurance and Quality Hold Points;

(iv) Proposal on product makes with details on Makes, OEM, MTBF, MTTR, Maintenance Support in requisite format and Approval thereof on the Manufacturer/ brand, Approval of samples, first fix installation before mass use/ replicating elsewhere;

(v) Manufacturer drawings needed for installation;

(vi) Construction and Installation Plan;

(vii) Prototype Test Plan;

(viii) Type test reports for equipment or components selected;

(ix) Factory Acceptance Test (FAT) Plan for equipment ;

(x) FAT Programme;

(xi) RAMS Plans;

(xii) Layout Drawings of equipment to be installed;

(xiii) Inter connection Drawings;

(xiv) Site test report of equipment;

(xv) Updated Earthing & Bonding plans ;

(xvi) Updated EMC Control Plan and certificates;

(xvii) Updated traction simulation model verified against testing data;

(xviii) Site access control system at TSS, SP & BSSP as per Appendix-11 of PS.

(d) As built documents

(i) As Built Drawings;

(i) Testing & Commissioning Reports/documents as required by the Engineer;

(ii) All other records of Construction for PSI Installations , OHE including hidden parts;

(iii) RAMS demonstration results;

(iv) Operation and Maintenance (O&M) Manual of the equipment coveringInstallation, operation and maintenance instructions;

(v) Other documentation as required by the Engineer.

(b) **Operation and Maintenance (O&M) Manuals** as specified in Chapter-17.

3.3.4 Proof Checking & Design Validation through an Independent agency as approved by the Engineer:

(1) The Contractor shall propose experienced team of experts for Design Validation andProof-Checking of Power Supply Distribution system through an Independent Agency/Consulting Company. The Agency/Consulting Company should have experts certified as Chartered Engineer including list of proven software / tools of using similar designas approved by the Engineer.

(2) The Proof-Checking & Design Validation Agencies/ Consultant(s) appointed by contractor shall assess the Validation requirement in consultation with Engineer, and identify design parameters as desired by the Engineer.

(3) The Proof checking & Design validation agency shall be fully responsible for utilization of accredited and proven software. The Proof checking & Design validation agency shall proof check & Validate the Design as desired by the Engineer including re-run of Validation as needed by the Engineer to assure the performance requirement. The process of deliverables of Proof-checking Agencies/ Consultant(s) shall include:

a. Validation and Submission of the Proof Checking & Validation report(s) to HORC on Detailed Designs related with Electric Traction system , Traction substations, Power supply & distribution system and equipment sizing as desired by The Employer / Engineer.

b. Interaction with The employer/ Engineer on Proof Checking & Validation results/ report(s), Demonstration of Validation tools to the Employer for appreciation of Proof Checking & Validation results, rerun of software and Clarifications thereof on the validation results to the Employer.

c. Review of Detailed designer's compliance on Validation results and (re) validation of the Design if any.

d. Endorsing the Certification on Contractor's designs & Drawings by the agency as 'Proof Checked & Validated' ascertaining adequacy, meeting application duty requirement and conformance to specification.

(4) The Proof-checking & design Validation agency shall have a proven experience of carrying out design/ proof-checking work of at least two assignments related with 25kV or 2x25kV Railway Electrification system. The proposed agency shall be approved by the engineer.

3.3.5 Scope of Items of work under Schedule-B:

The entire scope of work as mentioned above shall be in 2 parts ie Schedule A (Lumpsum contract) and Schedule B (IR/DFCCIL connectivity woks OHE (5 RKM and 14 TKM) along with SSP at Sultanpur & Asaudah and modification in Harsana Kalan IR SSP with feeders) as BOQ Based. The detailed scope of work under Schedule-B include design, supply, manufacture, construction, Installation, Testing & Commissioning, shall be as under:

(1) Sultanpur (IR connectivity from New Patli): all (1x25 kV) OHE works beyond chainage 3.900 km from New Patli station (chainage 0.000 km for connectivity) including modifications in IR yard.

(2) Sultanpur (IR connectivity from Badsa): all (1x25 kV) OHE works beyond chainage 3.100 km from Badsa station (chainage 0.000 km for connectivity).

(3) Sultanpur SP (1x25 kV): all PSI works along with PTFE, cross feeder and along feeder etc suitable for double line.

(4) Asaudah (IR connectivity from Mandothi): all (1x25 kV) OHE works beyond chainage 4.300 km from Mandothi (chainage 0.000 km for connectivity).

(5) Asaudah SP (1x25 kV): all PSI works along with PTFE, cross feeder and along feeder etc.

(6) Harsana Kalan (IR connectivity): all (1x25 kV) OHE works beyond chainage 124.300 km from Prithla station (chainage 0.000 km).

(7) New Prithla (DFCCIL connectivity from Prithla): all (2x25 kV) OHE works beyond chainage (-)1.500 km from Prithla (chainage (-) 0.000 km for connectivity).

(8) Prithla (connectivity with DFCCIL at Prithla): all (1x25 kV) OHE works at Prithla (HORC) for connectivity with DFCCIL line at Prithla.

(9) Modifications at Harsana Kalan IR SSP (along with SCADA) and provision of two 1x25 kV feeders from Harsana Kalan IR SSP to New Harsana Kalan OHE.

(10) The payment of Schedule-B works shall be made as item rates given in the tender. The specifications mentioned in this PS shall be applicable to both Schedule-A and Schedule-B.

3.3.6 Scope of Items of work under Schedule-A:

The scope of all items of work except those included in Schedule-B and necessary to complete the works shall be considered to be in Schedule-A (140 RKM and 306 TKM) and shall be Lumpsum Contract items. The Auxiliary Transformers with associated LT cable upto stations, auto change over panel at station along with all accessories for distribution of LT power supply and connection of Auxiliary Transformers to OHE etc at Sultanpur, Asaudah and New Harsana Kalan stations shall be part of Schedule-A (lumpsum contract). Entire SCADA system of SP at Sultanpur & Asaudah and motorized isolators at Sultanpur, Asaudah & New Harsana Kalan yard OHE shall also be part of Schedule-A (lumpsum contract).

3.3.7 Dhulawat station is proposed to be connected to Taoru station of DFCCIL by single line (approx. 5 TKM) with 2x25 kV high rise OHE system in future. Contractor shall execute this work (if required) and payment shall be made under schedule-B.

3.3.8 **Items of work excluded from the scope**

The following items of work are not included in the scope. However, the Contractor shall provide timely inputs as necessary to the relevant other contractors/Agencies:

(i) 220/132 kV transmission line network. However, gantry at TSS shall be made by the Contractor for termination of 220/132 kV incoming feeders with associated switchgear.

(ii) Trees in the alignment or in TSS/SP/SSP, if any, shall be removed by the Civil Contractor. However, the contractor shall coordinate with Civil contractor.

(End of Chapter 3)

CHAPTER 4 - DESIGN AND FUNCTIONAL REQUIREMENTS

4.1 GENERAL

4.1.1 The design, supply, construction, installation, testing and commissioning of the Traction Power Supply System, SCADA system, auxiliary power supply at 240 V , High Rise OHE and ROCS shall meet the design and performance requirements within the design environments as specified.

4.1.2 The Contractor shall carry out all investigations necessary for the design of the Permanent Works and enable the determination of the methods of construction and the nature, extent and design of Temporary Works.

4.1.3 The Contractor shall study environmental factors and design the Traction Equipment to render the best performance in the environment they are subjected to as per application duty and to determine suitable methods of manufacture and installation, both for Temporary and Permanent Works. In particular the Contractor shall ensure that the dusty environment, rocky terrain and earth resistivity do not have detrimental effect on the functionality, reliability or long term maintainability of the Permanent Works.

4.2 DESIGN ENVIRONMENT

The traction power system shall be fully operable and maintainable in the following climatic and atmospheric conditions:

Ambient air temperature Average ambient temperature for one year	(-)5^{0}C degrees to (+)50^{o}C 35 ^{0} C
Maximum solar gain of metallic object under the sun	1kW / sqm.
Maximum relative humidity	100%
Annual Rainfall	Dry Arid regions and also heavy monsoon affecting regions with rainfall ranging from 1750mm to 6250mm.
Maximum number of thunderstorms days per annum	85
Maximum number of dust storm days per annum	35
Number of rainy days per annum	120
Basic wind pressure *	120 – 200 kgf/m^{2,} as per wind map based on IS –875. For long bridges (more than 150m) and within 100m from their abutments on either side and on banks, where the height of the catenary above surrounding mean retarding surface is more than 30 meters, the specified 25% reduction in wind pressure shall not be reckoned for purposes of design.
Creepage distance for (i) Extreme pollution condition (ii) Polluted conditions	As per IEC 60815 – 2008
Horizontal Seismic Zone	Refer IS 1893 Part 1 for earthquake mapping

* The maximum wind pressure for the specified work area shall be obtained from the wind map as per IS 875 and used for the mechanical designs with the approval of the Engineer. The Thermal withstand capacity shall be considered at 0.5m/sec wind velocity.

4.3 FUNCTIONAL REQUIREMENT

4.3.1 The 2x25kV Traction Power Supply Systems on the Haryana Rail Orbital Corridor (HORC) shall ensure availability of reliable High Rise 2x25kV AT Feed (25kV AC for the yards) to the electric trains via overhead equipment and single phase, 240 V, AC supply for S & T installations along the route.

4.3.2 The Traction Power Supply System shall be monitored & controlled through a Supervisory Control and Data Acquisition (SCADA) System on the HORC.

4.4 DESIGN PHILOSOPHY AND REQUIREMENTS

4.4.1 Conformity with governing specifications and statutory requirements.

(1) This Particular Specification (PS) shall be read in conjunction with the Conditions of Contract, the General Specifications (GS) and documents forming part of the Contract.

(2) In the event of a conflict between the provisions of GS and this PS, the provisions of this PS shall prevail.

(3) In addition to the codes, standards and provisions mentioned in these specifications, the codes and standards that may also be applicable are:

(a) Relevant Indian Standards,

(b) Relevant RDSO specifications & standards,

(c) Indian Railways AC Traction Manual (ACTM),

(d) Design Manual for Electric Traction,

(e) Indian Electricity Rules1956 and Indian Electricity Act 2003,

(f) Safety Guidelines 2010 issued by CEA,

(g) IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION) Standards,

(h) EN (NORME EUROPÉENNE) European Standard,

(i) BS (British Standards),

(j) IEEE (Institution of Electrical and Electronics Engineers) Standards etc.

(4) In case of any conflict or inconsistency between the provisions of the codes/ standards as mentioned above and provisions contained in these specifications the provisions in these specifications shall prevail. However, the approval of the Engineer shall be obtained to follow the relevant codes/ specifications. The decision of the Engineer shall be final.

(5) The Contractor shall prepare and submit Technical Specifications (TS), which shall provide clear description of Functional & Performance requirements of each system, sub-system and equipment proposed along with Schedule of Guaranteed Performance (SOGP) matrix. The TS shall be drawn from the System Requirement Specification (SRS) as developed by the Contractor from the PS dulyinterpolated from the provisions in GS, contract documents and the relevant standards, The TS shall be submitted for the approval of the Engineeraccompanied with the Para Number wise 'Compliance statement on SRS' along with NIL Exception statement on SRS. 'Exception statement' with Un-complied item (s) if any of SRS shall be submitted to the Engineer with mitigation measures. However, no deviation shall be

permitted. The Technical Specification (TS) shall describe acceptable levels of performance for system/subsystem equipment / components within the environment condition stipulated above.

(6) The TS prepared by the Contractor shall include System / Sub-system/ Equipment wise Schedule of Guaranteed Performance (SOGP) in tabulated format comprising of following Information but not limited to:

a. System / sub-system /Equipment name,

b. Environment Condition ,

c. Designed temperature and De-rating if any required to the standard rating considered for highest ambient Temperature the equipment may experience,

d. Design life,

e. MTBF,

f. MTTR,

g. Schedule of Guaranteed Performances (SOGP) as applicable,

h. Testing & Commissioning requirements,

i. Mechanical & Electrical Interface with others,

j. Design Verification & Validation (V&V) check list,

k. Supply, Installation, Testing & commissioning (SITC) check list.

(7) SOGP shall be provided by the Contractor for each major equipment which shall be got approved from the Engineer. The Contractor shall identify the Name of the vendor, Place of Manufacture, manufacturer model/ part number of each system/ equipment, which he plans to install. The Contractor shall submit a proposal of approval in the requisite format as approved by the Engineer.

4.4.2 Proven Design and Cross acceptance criteria

(1) The Contractor shall develop the design based on this Particular Specification and good Industry Practices. The design details shall be submitted with supportive technical data/evidence of similar design and calculations to the Engineer for review and approval.

(2) The System, including all Sub-systems and Equipment shall generally be of approved RDSO / CORE design / specifications, wherever applicable. Such items shall be procured from RDSO/CORE approved Part I sources only. If there is no Part I source then the material can be sourced from a Part II source. List of sources are available at RDSO / CORE websites. These items shall be subjected to prototype testing as per relevant Specifications. Prototype test shall be exempted if the test was carried out in last five (5) years from the date of issue of Letter of Acceptance (LOA) and report of the same is submitted otherwise fresh prototype test shall be carried out and certificate/report submitted.

(3) The Contractor shall develop design and technical specifications for other items based on draft specifications (of RDSO) / functional requirement, if available, and prepare detailed specifications for approval of the Engineer.

(4) Cross acceptance criteria shall be applicable on the following:

(i) Items not covered by RDSO/ CORE specifications and approved list.

(ii) Items which has not been used in any Rail system.

(5) The cross acceptance criteria (CAC) shall fulfil the criteria as under:

(a) Last Three years satisfactory performance on AC Traction System from the date of issue of LOA, and

(b) The manufacturer should have supplied the equipment of minimum 70% rating of equipment offered. The Contractor shall furnish the details of its proven performance (certificate from the user) for such items, and

(c) The Manufacturer should have supplied at least 50% quantity to be used in this contract in last seven years OR they can supply, maximum two times the quantity supplied in last seven years (one month prior to date of Bid Opening).

(d) Prototype test report/certificate for offered item is to be submitted. Fresh prototype test is to be conducted, if the same has not been carried out;

(i) In last five (5) years from the date of issue of LOA ;

(ii) Considering the environmental conditions as specified in this PS.

(e) The Manufacturer shall have to support maintenance and repair of the equipment in India and supply spares till the design life of the material in India. The contractor shall submit an undertaking in this effect from the Original Equipment Manufacturer (OEM).

(6) Any approval to the prototype tests by the Engineer in no way shall absolve the contractor of his responsibility for the equipment, under the terms of the contract.

(7) The prototype test already done shall be valid only if it was done on identical equipment (same rating), manufactured with identical components / raw material, at the same manufacturing facility and to identical Quality standards.

(8) The above CAC criteria shall not be applicable for ROCS items. For ROCS, the items proposed for deployment shall conform to International Standards and RDSO guidelines. The system proposed should be designed for speed potential mentioned in PS clause 8.2.1 and the detailed design report shall be submitted. The validation of design shall be carried by third party design certification.

.

4.4.3 The designs shall be evolved along the following guiding principles:

(1) Service proven Design of same type;

(2) Low life cycle cost;

(3) Low maintenance cost;

(4) Use of interchangeable, modular components;

(5) Extensive and prominent labelling of parts, cables and wires;

(6) Use of unique serial numbers for traceability of components;

(7) High reliability;

(8) High Availability;

(9) Low energy loss;

(10) Fail safe design;

(11) Adequate redundancy in system;

(12) Compliance with relevant standards;

(13) Maintainable throughout the design life;

(14) Compliance with all statutory regulations.

(15) Future expandability

4.4.4 The contractor shall select a technology and equipment rendering equivalent or more life and better performance parameters as approved by the Engineer.

4.4.5 The General arrangement shall ensure that failure of one equipment / component or any single point failure does not impact the availability / performance of the Installation / Equipment.

4.4.6 The Contractor shall detail the maintainability requirements, and demonstrate that system maintainability conforms to the claimed system reliability and availability performance. The Contractor shall demonstrate that maintenance errors have been considered, and, as far as practicable, the risk of maintenance induced faults is mitigated in the design.

4.4.7 The Contractor shall demonstrate, to the satisfaction of the Engineer, that Insulation co-ordination for all electrical equipment is incorporated in the design of the Traction Power, OHE and SCADA system.

4.5 DESIGN SUBMISSION REQUIREMENTS

4.5.1 The Contractor shall demonstrate that designs for the Contract are in accordance with Employer's Requirements as specified in this PS, GS and Conditions of contract. The Contractor shall submit to the Engineer for review, relevant design information and drawings as identified under each phase/stage. Such submissions shall incorporate the relevant Standards as applicable.

4.5.2 The design submission schedules and their stages are detailed in relevant chapter of General Specifications.

4.6 PHASES/STAGES OF DESIGN SUBMISSIONS

There are four (4) stage submissions covering the Design Phase/stage viz. Preliminary Design, Detailed Design, Construction/Installation Design and finally the As-Built Documents.

4.6.1 Preliminary Design

In the preliminary design phase/stage the contractor shall submit inception report, Scheme designs and system simulation reports as specified in GS and this PS.

(1) Inception Report and Traction Simulation Study Reports:

(a) The Inception Report describing Approach/ Methodology to the design & execution of 2x25kV AT feeding System based on a study of freight systems around the world and to provide a cost effective and reliable design, Mobilization of qualified Design team, Review of Particular specifications and prepare SRS, schemes of the design, the Detailing on the Electric Traction System, Power Supply Installations, Traction Transformer(s), Auto Transformers, TSS/SSP/SP, OHE installations, Conductors & wires SCADA and RAMS and other performance obligations as described in the scope of work in the relevant chapter of this PS.

(b) Simulation Studies shall be undertaken based on the Employer's requirements and HORC Train Operation plan. The study shall determine the capacities of various elements, components as indicated in Clause 3.3 and shall form the basis of details in the Inception Report.

(c) The Inception Report and Simulation Study Reports along with sufficiently detailed drawings and documents shall be submitted for the purpose of review and approval of the Engineer. The approved inception report and traction simulation report shall then form the basis for the designs.

(d) The preliminary design shall incorporate all design requirements including standards, codes, performance requirement, design stresses and strains, electrical & mechanical properties of materials and all other documents or matters which are relevant to and govern the design. The Contractor shall furnish a Design Manual, which shall refer to all materials, codes and standards used, making clear their specific applications. The Design shall be produced so that it can be used by those involved in the preparation or review of the design of the Works as a comprehensive reference text and efficient working document.

(e) **Electric Traction System design**

Based on studies as detailed above, the contractor shall develop designs of the System and Sub-systems for traction power supply and distribution, finalizing ratings of the Equipment, switchgear, conductors & wires of the Traction Overhead System including Control & Protection Systems and SCADA. Safety Plan for the entire network including the work to be done for other contractors / agencies and IR for earthing and bonding, shall be drawn for approval by the Engineer. Works of Earthing & Bonding required on the adjacent Railway network of the Indian Railways of both electrified and non-electrified systems, in proximity to the Freight Corridor, against induced current from 2x25kV AT Feeding System shall be implemented as per sub clause 3.3.1(6), so as to provide a safe environment. The Preliminary and Detailed Design Report submission shall also provide details for, but not limited to, the following:

(i) The design shall be coordinated to accommodate the requirements of adjacent sections, Signalling system. Final track-work, including drainage and service roads and any specified design requirements that those systems or facilities may dictate for the operation and management of the system.

(ii) The alignment of storm water drains along the track shall be coordinated with civil contractor to ensure that the alignment of the OHE structures and storm drains do not obstruct each other.

(iii) The OHE final design shall be engineered by the Contractor with consideration to the design criteria, specifications, codes and standards contained or referenced in the Employer's Requirements.

(iv) The Contractor shall develop Earthing and Bonding Plans covering all the buildings, structures and adjacent Indian Railway tracks or DFCCIL tracks or any other Utilities or metallic structures in proximity belonging to other independent authorities to provide protective provisions against EMI from 2x25kV traction currents and to limit touch potentials as a result of Simulation study so as to provide a safe environment.

(v) The design of OHE supports on bridges and ROCS supports in the tunnel, their earthing shall be coordinated with Civil Contractors.

(f) In addition, the Contractor shall submit during this design stage the following:

(i) The Design Submission Program in line with requirements of Chapter-4 of G.S. [Project Programme Requirements],

(ii) Validation of Data including Geotechnical Investigation and Drawings provided by the Engineer and additional Surveys required to be carried out by the Contractor,

(iii) A study of the Final Alignment Drawing for assessing the type and quantum of Traction Overhead work required and for planning the supply of materials and execution of the work within the time frame finalized in accordance with the Coordinated Events and key milestones available for access to the site of Works,

(iv) A study of Right of Way (ROW) for adequacy of land in the station yards, approaches and the land acquired for TSS, SSP and SPs where traction installation are planned,

(v) A proposal of the Work Areas outside e.g. proposed locations and design of Contractor's Temporary Works i.e. construction depots, plants, steel, fittings and other component stock pile areas, storage, workshops, camping areas etc. required to execute the Work according to the time frame,

(vi) Main line, tunnel and Station Yard OHE Layout Plans and their sectioning,

(vii) General Arrangement of equipment at Traction Power Supply and Control Posts,

(viii) OHE joining with DFCCIL and IR system and slewing plan of OHE for Indian Railways' adjoining tracks infringing location of Masts, if any and Connection with OHE of adjoining section. Joining of High Rise OHE with normal height OHE (5.6/5.8 m contact wire height).

(ix) Design of OHE structures on bridges (Important and Major Bridges), and viaducts and in tunnel.

(x) Design of OHE under over- line structures such as ROBs, Rail Fly-overs, through girder bridges, Foot Over bridges etc.,

(xi) Earthing and Bonding diagram for structures, ROCS system and metal work along the track and in portion joining Indian Railways and DFCCIL.

(xii) Submit Method Statements covering the following:

a. Construction methods for installation of equipment and structures at TSS, SSPs and SPs including Earth mats and OHE including AEW, NFW and BEC (if required).

b. Construction machinery and equipment to be used for foundation work, Mast erection, Bracket erection, Wiring, adjustments etc.,

c. Software's to be used for design activities,

d. Design Reviews including Checklists.

(xiii) Two original sets of the full edition of the publication / technical standards including Codes, manuals & Standards and other documents that the Contractor proposes to use or used for the Work.

(xiv) Combined Services Drawings (CSD);

(xv) The Traffic Management Plan for working of the OHE Construction/ work Train;

(xvi) Proposed on site and off site testing arrangements for testing and quality control of input materials; and

(xvii) Manufacture, Installation and Construction Methods;

(xviii) Procurement Program for Manufactured Items;

(xix) Proposal for physical progress report & basis for measuring the progress of the Work;

(xx) List of technical documents, which Contractor proposes to prepare and submit to the Engineer for his approval;

(xxi) RAMS specifications and studies expected during the Project to demonstrate the achievement of specified targets ;

(xxii) SCADA study including system architecture;

(xxiii) List and documents for the items/ equipment requiring cross acceptance criterion shall be submitted.

4.6.2 Detailed Design Stage

(1) The detailed design of the Works shall be developed by the Contractor based on the approved Inception, approved traction simulation Report and approved Preliminary Design.

(2) Submission during detailed Design may be divided into multiple submissions as per the Submission Program approved by the Engineer. In such a case, each submission shall include correlated and interdependent submittals so that each submittal is logically independent and consistent. The submissions at different stages shall be integrated and compiled into one package at the time when the final submission is made and the compiled documents and Drawings shall be submitted to the Engineer for issue of Notice of No Objection and will be collectively referred to as the detailed Design. Every design document shall be submitted along with the Design report, Supportive Calculations, reference standards used, drawings with legends and Quantity Take-off sheets. Sub sheet(s) shall carry the master inset with clouding the relevant portion of the drawing in the sheet(s).

(3) The detailed Design Submission shall be a coherent and complete set of documents, properly consolidated and indexed and shall fully describe the proposed Technical Design. In particular, and where appropriate, it shall define butnot limited to :

(a) The dimensions of all major features, structural elements and members;

(b) All components and their specifications;

(c) Location, geometry and setting-out of all main elements and features;

(d) Provisions and proposals for construction interfacing with the other contractors and Interfacing parties; and

(e) Traffic Management for delivery of materials and execution of work.

(f) Submission of calculations on OHE related items as under but not limited to:

i. Calculation for adequacy of size of OHE structures (along with AEW and NFW) selected for alltypes of typical OHE locations, Critical locations, Fixed Terminations, ATDs, overlaps, turnouts, neutral section, sharp curves, cross feeder gantry, along feeder and other Conductor support structures

ii. foundations

iii. Cantilever & Conductor sizing calculations

iv. Cantilever movement with temperature

v. Impact of temperature variation & climatic conditions

vi. Conductor sag calculations

vii. Any other calculation as per EN50119 and as required by the Engineer.

(g) submission of calculations on Power Supply Installations as under but not limited to:

i. Calculation for adequacy of size of Battery system,

ii. power supply equipment,

iii. Cable sizing and UPS sizing

iv. Overload, Short circuit, harmonics, voltage imbalance and Voltage drop, Power factor, losses

v. Equipment & component support structures,

vi. Bus bar system,

vii. Earthing system, step & touch potential rise

viii. Lightning Protection system etc.

ix. Any other calculation as required by the Engineer

(4) The Contractor shall not, without the prior written consent of the Engineer:

(a) Revise or alter the content of any document and / or Drawings in the design Contract Package – SYS-1 which have been submitted to and approved by the Engineer. The Technical design shall be developed based upon the previous submission(s) unless otherwise the Engineer approves the change in the contents. Every revision of Drawing / document shall have a unique revision number, revision date including that of the reference drawing / document referred therein for establishing the traceability.

(b) Reduce the periods provided for review by the Engineer of any submission of design, design data and materials as set out in the Design Submission Programme;

(c) Revise the sequence of submissions of design, design data and material as shown in the Design Submission Programme.

(5) Detailed Drawings and Documents

The Drawings shall be a set of Drawings which describe integral feature of the

Permanent Works strictly in compliance with the Employer's Requirements including, general arrangements, and layouts of structures, all materials with associated fittings, all machinery and equipment with associated fittings and Drawings which supplement the above. The Contractor shall submit including but not limited to the following Drawings:

(a) **OHE**

(i) The OHE layout plan (LOP) of the Traction Overhead equipment on the Final Alignment Plan of main line and the yard plans, including but not limited to connection to IR and DFCCIL tracks; OHE LOP of ROCS in tunnels and its connection to flexible

(ii) OHE profile Drawings through Over-line structures, bridges &viaducts;

(iii) General arrangement, location plan, geometry, and setting out Drawings;

(iv) The Cross Section Alignment Drawings at all OHE structures;

(v) The Structural Drawings for Masts and Portals for OHE and Switchyards of Traction Supply Posts.;

(vi) Earthing and Bonding Plans;

(vii) OHE Sectioning Diagrams of main lines and yards;

(viii) Details of connections with Indian Railways and adjoining DFCCIL sections including the details of sectioning and traction control switching;

(ix) OHE Structural Steel–masts and portal structures for support of the Overhead Conductor(Head spans shall not be used except at locations where the Contractor has received written permission from the Engineer);

(x) Small part steelwork Fabrications – galvanized small part steelwork (SPS) assemblies required to support OHE, some of which may be special structural assemblies;

(xi) Foundation Layout of Structures and Equipment;

(xii) Cross section drawings and SED drawings.

(xiii) The ROCS system shall be designed for speed potential mentioned in the Particular Specifications and the detailed design report shall be submitted. The validation of design shall be carried by third party design certification.

(b) **Traction Power Supply System**

(i) Cross section, Elevations Drawings, General arrangement and Equipment Layout plan for of TSS, SP, SSP, ATS (if any) and other installations;

(ii) Level & filling cross section Drawings of TSS, SP & SSP;

(iii) Incoming/Outgoing EHV transmission lines termination Gantry at TSS;

(iv) Gantry for 25kV AT outgoing feeder to the OHE;

(v) Architectural Control Room layout of TSS,SP and SSP and at ATS (if any);

(vi) Layout of Earthing system;

(vii) Lightning Protection System at TSS, SSP, SP;

(viii) Fencing Layout;

(ix) Typical Equipment Layout of Control Room Building for TSS,SSP and SP;

(x) Cable trenches layout along with cross section;

(xi) Drainage of TSS Yard including that for Cable trenches (Control and containment of oil spills should be kept in view during design of the transformer bay(s));

(xii) Outdoor yard layout, Bus bar supports;

(xiii) Outdoor yard Illumination Lay Out;

(xiv) Clearance Drawings of outdoor equipment, bus bars and conductors;

(xv) Cable Run Layout;

(xvi) Combined service drawings;

(xvii) Battery and battery charger details;

(xviii) Connection of TSS/ SSP/ SP to Adjacent Track;

(xix) Switch Yard Slope and Drainage Drawings;

(xx) Soil Bearing Capacity and Soil Resistivity;

(6) Detailed Design Report

(a) The Detailed Design report shall be of narrative type describing the detailed Design Submission including its Title, executive summary, Purpose, assumptions, Input Data, Step wise Calculations with reference of the Formula used, Reference standard with Para / clause number, Summary of output results and relationship with other submissions / reference. It shall include, a guide to all relevant technical data used and outline the design approach, standards used, design calculations & analysis particularly in respect of Traction Power Supply, OHE Components and arrangement,OHE sectioning, the protection scheme and the interlocking provided for a safe and reliable traction system. The design Report shall specify the limitations for the first failure situations as a part of the reliability study.

(b) Structural analysis report including loading diagram and input & output files of the approved software used for the design of traction structures.

(c) For traction Power Supply System complete design document in respect of all the systems, equipment / components viz. earthing, HT/LT panels, interlocking arrangements, cabling layout, internal wiring, conduiting and general electrification works as per Vol-5 Particular Specifications for E&M, and Associated Works.

(d) The report shall also include design submissions, EMI Mitigation/ EMCcontrol and earthing & bonding plans for approval by the Engineer so as to ensure appropriate execution by contractor of these safety works, the completion of which is a necessary pre-requisite for completion of the project.

4.6.3 Construction/Installation Design & Drawings

Based on the approved Detailed Designs, The Contractor shall develop the construction/ Installation designs and Construction Reference Drawings (CRD) for implementation at site as specifically required for each location.

(1) It shall have the reference of the approved detailed design/ drawing, Method statement, safety & quality check guidelines and Special Gadgets required for the execution.

(2) It should contain all the information as required for Detailed Interface requirements.

(3) It should contain all the information as required for the Execution and Checking.

4.6.4 As-Built Documents

The Contractor shall produce the 'As Built drawings' for the work executed but not limited to the list of drawings identified in para 4.6.2 including the following :

(1) Dated Records of Measurements and Records of Test results;

(2) Dated Evidences of execution i.e.

  a. Monthly Progress Photographs & Videos of all the activities of work executed,

  b. Progress Photographs of hidden work before covering/concealing.

(3) Execution Report etc.

(End of Chapter 4)

CHAPTER 5 –PERFORMANCE REQUIREMENTS FOR TRACTION POWER SUPPLY SYSTEM

5.1 GENERAL

5.1.1 Traction power supply system shall be capable of meeting the projected demand of the Train service with each TSS equipped to deal with exigencies due to outage of adjacent TSS of Prithla to Badsa Section and Badsa to New Harsana Kalan Section.

5.1.2 For the purpose of Power supply reliability, double circuit 220/132kV Power supply has been planned from Haryana Power Supply Authorities for both the Traction Sub Stations (TSSs) installing 220/132kV bays incomer CBs, Bus coupler Circuit Breakers and Transformer Circuit breakers etc.

5.1.3 The TSSs shall be equipped with main Scott connected transformer and stand by Traction Transformer with adequate spare Capacity as detailed hereunder**:**

(1) TSS shall be equipped with transformers with spare / stand by Capacity andin Numbers as required along with associated switchgears. The TSS shall be able to supply full power even in case of failure of any equipment or a set of Bay Equipment or bay is out of Service or under failure/ maintenance through other Equipment / bay. In case of availability of any one incomer 220/132kVsupply up to transformer terminals (while other Circuit could be in failure/ maintenance) the TSS shall be able to supply power to OHE through CRISS-CROSS redundancy even if one transformer or one equipment of any bay is failed or under maintenance or not available for use.

(2) Both the TSSs shall be provided with one set of transformers/equipments in operation sized to continuously 100% power in extended feed scenario without any compromise in any performance parameter.

(3) Subject to Engineer's approval, the Contractor shall be allowed to do a value addition and can make own layout arrangement within the space allocated without reduction in flexibility available in existing arrangement or any compromise in performance.

The indicative typical TSS conceptual Scheme Diagram of TSS is attached in Part-2, Section VII Volume 3: Tender Drawings.

5.1.4 Normal feeding Scenario

'Normal Feeding Scenario' is defined as 'Both TSS are supplying power up to the neutral section on both sides up to adjacent SP. As there are only 2 TSSs, so Badsa SP is the common SP of both the TSSs. The Normal Scenarios shall include 'All traction equipment in service, with TSS supplying power up to the neutral section on both sides up to adjacent SP as well as the scenario as listed below:

1. 220/132 kV Bay Normal Scenario

(a) Both the incomers are available. 220/132 kV Bus coupler in open condition. Only one of the 220/132 kV Incomer bay is taken on load. Both the 220/132 kV incomers are independently rated to take full load of the TSS.

(b) In case, One of the incomer supply is not available or any 220/132 kV bay equipment are under fault / maintenance, the Power supply shall be available through healthy 220/132 kV bay to connected traction Transformer bay or through remotely scada operated 220/132 kV bus coupler to other

Transformer Bay.

2. **Traction Transformer Bays**

(a) TSS with Main and Standby Traction transformer

i. All the Traction Transformer(s) are healthy along with 220/132 kV HV and LV (55/2x25kV) side switchgears and protection CT.

ii. If one of the Traction Transformer or Transformer bay equipment is not available due to fault /maintenance, the Traction Load shall be serviced by the available standby Transformer(s) or transformer(s) Bay without any impact on train operation performance. The switching over of loads between Transformer(s) shall be resorted to, for better life of transformer(s). Employer may choose to keep other standby transformer in charged and offloaded condition for short/ long time before switching over of load in line with philosophy adopted on Indian Railways.

3. **55kV/2x25kV Bus bar**: Bus bar shall be sectionalised to allow feed by either of the healthy Transformer / Transformer bay(s) with Bus coupler normally closed. In case of Half Bus out of service due to maintenance / fault, the Power supply shall be routed through half of the healthy bus.

4. **Feeding bays**:

(a) Each bay feeds the respective right / left side of OHE system.

(b) In case of failure of one of the bay, other bay takes care to supply the Right / left side of the power supply control post.

(c) Redundant capacity of all equipment of the bays shall be built in for the purpose of reliability.

(d) The bays with Auto Transformers (ATs), shall be suitably designed to allow the availability of supply through alternate route in case of failure. The capacity of ATs shall be suitably upsized with such consideration.

5.1.5 **Emergency Feeding Scenario is defined as "A failure condition** as per thefollowing details:-

(1) The TSS could be under outage due to both the incomer feeder outage, the Transformer bay(s) outage, 55kV/ 2x25kV Bus bar faulty or all the ATs of the TSS are out. The feed is extended from the adjacent healthy TSS till to the Neutral section at SP of the Outage TSS. Feed extension requires the Bridging circuit breakers to be closed at an SP and the supply from healthy TSS is extended up to neutral section at SP of adjacent outage TSS.

(2) And the isolation of a single Auto transformer in the section.

5.1.6 Under all emergency feeding conditions; full designed headway service shall be feasible without any loss of performance.

5.1.7 **First failure conditions performance requirement – Under Failure of One TSS, the power will be extended from the adjacent TSS.** Traction power supply system shall be capable of meeting the projected demand of the services with each TSS designed to deal with exigencies from one adjacent TSS going out of service to facilitate extension of feed up to Neutral section of SP of Outage TSS. Under first failure condition (N-1), full design headway/ train service shall be maintained without any loss of performance.

The contractor shall identify and describe the conditions of all Single point Failure at TSS, SSP, SP and ATs and assess & quantify the impact with requirement of Power rerouting and the energy requirement in kWh and MVA peak load.

(1) All the equipment shall be sized considering the single point failure at the location and one TSS failure with required safety margins (in rating) to meet the application duty requirement of the most stringent power requirement without affecting the power quality.

(2) One TSS outage may persist continuously for a number of days until the defective equipment is replaced. The Single point Failure and TSS outage shall not use the overloading capacity of the equipment as prescribed by standards.

(3) The Traction transformer/ Transformers shall be rated for full capacity to meet the power requirement of the extended feed scenario.

5.2 ROLLING STOCK CHARACTERISTICS AND TRAIN OPERATION DATA

5.2.1 Traction power supply for Prithla to New Harsana Kalan section of HORC shall be designed taking into consideration the rolling stock characteristics and train operation data given below in Table 5.2.1 and Table 5.2.2. The Tractive effort Vs Speed Characteristic of 12000HP locomotives to be utilised on HORC shall be as included in the Part-2, Section VII Volume 3 : Tender Drawings. The following data shall be used for all normal and emergency performance requirements of traction power supply system.

Table 5.2.1: Rolling stock characteristics **

Item	Values
Maximum permissible speed	160 km/h
Adhesion	40% Starting (Indicative)/ 30 % Continuous
Locomotive weight	Weight 180 tonnes ± 1% upgradable to 200 tonnes + 1%.
Starting Tractive effort (up to speed not less than 10 kmph)	Not less than 785 kN for 25 T axle load
Type of rolling stock	BoBo+BoBo, 8 axle Locomotive hauling BOXN and bulk wagons.
Type of Braking	Electrically controlled-pneumatic service friction brake, Electric regenerative brake for the loco
Pneumatic brake effort	7 % - 9 % of gross weight
Emergency braking distance (with pneumatic brake only)	900 m maximum for light engine from 100 Kmph to standstill on level tangent dry track
Efficiency of propulsion system	Not less than 87% at full load
Auxiliary Power requirement of Locomotive	300kVA

Ref: RDSO specifications no. RDSO/2006/EL/SPEC/0044 Rev. '13' for 12000 hp locomotive.

5.2.2 These characteristics are as per RDSO Specifications and are subject to confirmation from IR. Further details such as power drawn, harmonics and various time and distance characteristics for Level of services at design headway shall be ascertained from IR.

Table 5.2.2: Train Operation plan

SN	Train Operation Plan
1	The contractor will prepare the train operation chart considering the traffic requirement of passenger and goods trains as given in clause 3.2.5 of PS..
2	The goods trains per day shall be a mix of single and double trains in the ratio of 2:1 for both UP and DN trains.
3	Train operation time shall be 20 hours and 4 hours shall be maintenance time per day.
4	For double trains – 13000 T; For single train – 6500 T.
5	Passenger trains load shall be 26 AC coaches per train.

Note: The trains in the Initial period will be generally hauled by WAG-5, WAG-7 and WAG-9 and 9000 HP locos of Indian Railways.

5.3 VOLTAGE REQUIREMENTS

5.3.1 Traction power supply system for Prithla to New Harsana Kalan section of HORC shall meet the requirements given below in Table 5.3 in respect of maximumand minimum voltages at any overhead current collection point.

Table 5.3 Voltage Requirements (as per EN50163)

Item	Values
Nominal voltage	25 kV A.C.
Lowest Permanent Voltage	19 kV A.C.
Highest Permanent Voltage	27.5 kV A.C.
Lowest Non – permanent Voltage	17.5 kV A.C.
Highest Non - permanent Voltage	29 V A.C.

5.3.2 The requirement of voltage and frequency shall meet the requirements given in EN50163.

5.4 PERFORMANCE FEATURES

The Traction Power Supply (TPS) shall be designed such that any single key components may fail without impact on the operational performance of the overall Electric Traction system. This shall be demonstrated by calculation of the load flow in case of outage of critical main components

5.5 SYSTEM REQUIREMENTS

5.5.1 Train Operations

The system shall be designed to fully satisfy the operational requirement as per the "Train Operation Plan" given in table 5.2.2.

The train resistance and locomotive resistance data as followed by IR is given below:

(1) Train resistance (of BOX N wagon excluding Locomotive)

(a) Main Line starting resistance on level tangent track (including acceleration reserve) = 4.0 (in kg/tonne)

(b) Main Line running resistance on level tangent track = 0.6438797 + 0.01047218 V + 0.00007323 V^2 (in kg/tonne), where V is speed in Kmph

(2) Grade resistance = 1/G x 1000 (in kg/Tonne), where G is gradient (e.g. G =200 in case of 1 in 200 gradient)

(3) Curvature resistance = 0.4 x curvature in degree (in kg/tonne)

(4) Locomotive resistance

(a) Starting resistance on level tangent track = 6.0 (in kg/tonne)

(b) Running resistance on level tangent track = 0.647 + 13.17/W + 0.00933V + 0.057/WN x V^2 (in kg/tonne) ,Where W = Axle load of the locomotive in tonne N= Number of Axle, V = Speed in km/ph

(5) The signaling system of the route shall be absolute block working type..

(6) For failure of one TSS, the system shall be able to support 100% train service under normal and emergency feeding conditions. The regeneration figure shall be considered zero for simulation purpose. For Traction Power Simulation consider stoppage of trains at alternate stations, maximum dwell time of 5 minutes and wind speed of 0.5 m/s and Power factor of 0.95.

5.5.2 System Wide EMI Mitigation/EMC, Earthing and Bonding strategy

(1) Based on the simulation studies, the Contractor shall develop an EMI Mitigation/ EMC strategy and Earthing & Bonding scheme for the entire system to ensure safe touch & step potentials for the traction installations and those of track and metal work of other installations of Prithla to New Harsana Kalan section of HORC. This strategy shall also include installations of other parties affected by the traction currents. The strategy shall be designed & developed for incorporating the Traction System Installations of track, bridges, viaducts, tunnel and other adjacent metallic structures, protective works for electrical circuits, signal and telecom installations and also include other parties which may be affected.

(2) The Contractor shall ensure that step and touch potentials do not exceed the voltage limits as stipulated in EN 50122-1 during failure of Overhead equipment, snapping of conductor, Insulator leakage and locomotive fault exceeding duration of 300 ms**,** as minimum, subject to back up protection clearing the fault within this period to be confirmed by the contractor which, shall be demonstrated through design calculations.

(3) The Contractor shall simulate the worst condition scenario including the failure of insulator, Rail fracture, earthing of broken conductors etc. as per EN50122-1.

(End of Chapter 5)

CHAPTER 6 - DESIGN CRITERIA & PERFORMANCE SPECIFICATIONS FOR TRACTION POWER SUPPLY SYSTEM

6.1 CONCEPTUAL POWER SUPPLY ARRANGEMENT

6.1.1 Conceptual schematic power supply arrangement diagrams of typical TSS/SSP/SP are furnished in the Part-2, Section VII Volume 3: Tender Drawings Based on the conceptual schematic Drawings, the Contractor may review, improve layouts/ arrangements to optimally utilize the space.

6.1.2 The typical TSS Power supply arrangement is planned to meet power supply for the electrification work of Pithla – New Harsana Kalan section and connecting lines to Indian Railways.

6.1.3 Traction Substations (TSSs)

1) The Power Supply for Prithla to New Harsana Kalan section of HORC will be brought from Grid Substation of Haryana DISCOM by 220/132 kV 3-Phase, double circuit transmission line network. TSS equipment and Bus bars shall be suitably designed and capable to feed the extended feed zone as per application duty requirement.

2) TSSs in the section shall be provided with equipment/ functionalities as below and as per the typical indicative schematic included in Part-2, Section VII Volume 3: Tender Drawings, but not limited to provision of:

(a) Incoming Bays for receiving 220/132kV double circuit power supply at TSS, the Gantry and Overhead cross feeders including terminations and insulation. Incomer bays shall have isolators and Circuit Breakers (CB) arrangement. Both the incoming bays should have facility of quick switchover of power from one 220/132 kV bay to the other 220/132 kV bay by means of 220/132kV Bus-Coupler Circuit Breaker and motorized Isolators.

(b) Outgoing Bays shall have provision of termination of 220/132 kV, 3-phase, double circuit power supply, the Gantry and Overhead cross feeders including terminations and insulation. Outgoing bays shall comprise motorized isolators andCircuit Breaker (CB) arrangement as required as per Indicative Arrangement included in Part 2, Section VII-3.

(c) Metering Bays with Check meters, Metering CT, PT and the associated insulation, protection and Monitoring arrangement, as per Utility's specifications (Power Supply Authority as case may be) with required communication ports, on the 220/132 kV incoming side in a separate cubicle at each TSS, which should have communication with OCC through SCADA.

(d) 220/132 kV all isolators motorized with / without earthing heels;

(e) 220/132 kV Bus bar arrangement;

(f) 220/132 kV, AC Triple pole Circuit Breakers,

(g) 220/132 kV – Protection Current Transformers , Potential transformers,

(h) 220/132 kV, AC, Triple pole Bus Coupler circuit breaker with motorized Isolator;

(i) 220/132/55 or 2x25kV Traction Transformer(s) complete with all accessories;

(j) Circuit Breakers suitable for 2x25kV AT feeding System,

(k) Bridging interrupters suitable for 2x25kV AT feeding system;

(l) Double pole isolators, suitable for 2X25 KV AT feeding system;

(m) Lightning arrestors for 132 kV, 55kV and 2X25 KV AT feeding system as required;

(n) 55/2x25 kV & 25kV Rigid Bus bar arrangement along with required insulation and isolation and 100% redundancy,

(o) 25 kV Bus Coupler CBs as applicable.

(p) Auto transformers (as required by design);

(q) Auxiliary transformers 2 nos. 100kVA for 25kV/240V single phase supply at TSS;

(r) Single core and multi core copper Conductor, XLPE insulated cables **(**for 25kV and control Cables as required) ;

(s) Return current circuit cabling (minimum 3.3kV, single core) and bonding for the tracks in close coordination with Other Contractors/Agencies; Earthing and Bonding system including Buried Rail for efficient Traction return current;

(t) Control & Protection system comprising of Protection relays, Control Relay panel and CTs / PTs,

(u) Batteries and Battery Chargers;

(v) Power quality improvement equipment to keep harmonics and voltage unbalance within the specified limits at rated Capacity;

(w) Power Factor Improvement Device to improve power factor up to 0.95 or better.

(x) Automatic Fault locator

(y) RTU and control equipment

(z) All civil works and general & yard lighting

6.1.4 Sub Sectioning Posts (SSP)

Sub-Sectioning Posts for 2X25 KV AT systems and as per the indicative schematic included in Part-2, Section VII Volume 3: Tender Drawings, in the section includes, but not limited to provision of:

(1) Double pole circuit breakers for 2X25 AT system with Protection relays as required to automatically isolate fault section/ equipment.

(2) Double Pole interrupters for 2X25 AT system;

(3) Double pole isolators for 2X25 AT feeding system;

(4) Double Pole isolators (motorised) 2x25 kV for feed extension;

(5) 55 kV Auto Transformers;

(6) Auxiliary Transformers 10kVA, 25kV/240V, single phase;

(7) Single core and multi core Conductor, XLPE insulated cables;

(8) Return Current Circuit Cabling;

(9) Earthing and bonding system;

(10) Batteries and Chargers;

(11) Lightning Arrestors;

(12) Automatic Fault locator

(13) RTU and control equipment

(14) All Civil works and general & yard lighting.

6.1.5 Sectioning and Paralleling Posts (SP)

Sectioning and Paralleling Post for 2X25 KV AT systems and as per the indicative schematic, Part –2, Section-VII-3 includes, but not limited to provision of:

(1) Double pole circuit breakers for 2X25 AT system with Protection relays as required to automatically isolate fault section/ equipment.

(2) Double Pole interrupters for 2X25 AT system;

(3) Double pole isolators, for 2X25 AT system;

(4) 55kV Auto Transformers;

(5) Auxiliary Transformers 10 kVA, 25kV/240V,single phase;

(6) Single core and multi core copper Conductor, XLPE insulated cables;

(7) Return Current Circuit Cabling;

(8) Earthing and bonding system;

(9) Batteries and Chargers;

(10) Lightning Arrestors;

(11) Automatic Fault locator

(12) RTU and control equiptments

(13) All civil works and general & yard lighting

Note: The SP at Sultanpur (for double line) and Asaudah (for single line), as approved by Engineer, shall be of 1x25 kV system and shall have following equipment but not limited to;

(1) Single Pole interrupters for 25 kV system;

(2) Single Pole isolators, for 25 kV system;

(3) Double Pole isolators for 25 kV system;

(4) Auxiliary Transformers 25 kVA, 25kV/240V,single phase;

(5) Single core and multi core copper Conductor, XLPE insulated cables;

(6) Return Current Circuit Cabling;

(7) Earthing and bonding system;

(8) Batteries and Chargers;

(9) Lightning Arrestors;

(10) Earthing & and bonding Buried earth rail;

(11) RTU and control equipment

(12) All civil works (for double line compatibility) and general & yard lighting

6.2 DESIGN OF THE POWER SUPPLY SYSTEM

6.2.1 The Contractor shall propose to the Engineer a proven multi train system simulation software to be used taking into account the data for rolling stock, train loads, driving pattern speeds, stoppage, track alignment, curve and the Scheme of Electric Traction System as stipulated in clause nos. 3.2 of this specifications. The Contractor shall propose the various simulation runs to be undertaken to confirm system performance parameters and the equipment sizing, for Engineer's approval.

6.2.2 This Simulation study shall also be used to determine the sizes & rating of 220/132 kV, 2x25kV and 25kV Traction equipment such as Traction Transformers, Auto Transformers, circuit breakers, Interrupters, isolators, 220/132 kV Flexible and 55 & 25kV Rigid bus bar as required for TSS, SSP and SP, all traction power conductors and sizeof 25kV A.C. contact wire, catenary wires, ROCS conductor and feeder wire of the overhead equipment, Aerial Earth Wire (AEW) and Buried Earth Conductor (BEC, if required) taking in to account, the temperature rise in conductors, Thermo-dynamic stresses as per the application duty requirement and Emergency scenario as defined in this PS. The rating of the Auto transformers shall be same for all locations of SP/SSP and TSS as required as per design.

6.2.3 The Simulation software shall produce output as a minimum for the following, both during normal feed i.e. TSS in service and during extended feed i.e. one TSS out of service:-

(1) Voltage profile at pantograph of each train simulated under normal & abnormal (N-1) conditions;

(2) Capacity of Traction Transformers;

(3) Current output of each TSS, both Peak and RMS current

(4) Conductor temperature rise including feeder wires;

(5) Load Flow study and Short Circuit study to identify the Current carrying Capacity and short circuit withstand Capacity of each circuit breaker or interrupter, Bus bars and TSS/SSP/SP equipment including current at all node points;

(6) Sizes of Catenary, contact wires, ROCS conductor (considering 30% worn out condition as per EN 50119), feeder wires, and jumper wires including the feeding Cables.

(7) Touch and step potential of Traction Rail, interval of grounding of earth wire (AEW) and Buried Earth Conductors (BEC, if required) to connect rails either directly or through impedance bonds.

(8) Voltage Imbalance / Fluctuation and Harmonic Distortion

(9) EMI/EMC study

6.2.4 Anticipated short circuit levels are given in Table 6.5.1. Based on the traction power system requirements and Traction power Simulation studies, the Traction power supply system shall be designed. Sizes and ratings of all equipment, cables of different voltages 220/132 kV, 25kV A.C. and 240V A.C. auxiliary supply, earth bus and conductors, joints, jumpers, as well as ancillary equipment and instrument transformers shall be finalised. All the equipment and bus bars shall be designed to with stand the thermodynamic stresses caused by the stringent Short circuit fault scenario the system may witness. The Jumper current carrying capacity shall match with current carrying capacity of catenary and contact wires.

6.2.5 The details of calculations and specifications finalised shall be submitted to Engineer for approval.

6.2.6 The multi-train simulation study shall be used to verify the capacity of traction substations, Sectioning Posts, Sub-sectioning Posts evolve design to meet the traction power demand and voltage requirements for train operation Plan and application duty requirements satisfactorily for all power scenarios identified in relevant chapters and as under but not limited to;

(1) Normal feed conditions and Extended feed conditions with one adjacent TSS out of Service;

(2) Normal Feed condition with Single point failure scenario either One source out of Service or One 220/132 kV Bay out of Service or One Main Traction Transformer / Traction Transformer Bay is out of Service or One of the 55 kV Bus bar or Half bus out of Service;

(3) If one line feeder breaker fails, (supply shall be routed through other bay by closing the paralleling CB/interrupter to ensure availability of power with single point failure)

(4) To specify the optimum interval between rails to earth connections to ensure that the rail voltages are within permissible limits as per IEC 62128/EN 50122/ EN50522.

(5) Max power demand in case of extended feed condition and minimum voltage at pantograph under worst condition i.e at the farthest end;

(6) Catenary current & temperature rise in conductor under extended feed condition, with contact wire worn out by 30%;

(7) Failure of Capacitor bank;

(8) Failure of Power quality equipment at TSS;

(9) One AT failure at TSS or SSP or SP;

(10) Extended feed conditions with one TSS out of Service with all the features as above of normal scenario;

6.2.7 This specification gives indicative details of power supply arrangements envisaged for traction power supply system for the Prithla to New Harsana Kalan section. The Contractor shall examine the entire scope of work and scrutinize the specified system, the specifications of cables and equipment and work out the ratings based on his own designs of the entire system without compromising the redundancy and reliability, availability and Maintainability.

6.2.8 Fire detection and Protection system including Fire walls and Barriers as conforming to international standards NFPA 221 and 851 at TSS, SSP and SPs shall be provided to protect against the fire risk.

6.2.9 Insulation level of the equipment selected shall be in conformance with EN50124-1 and IEC 60071-1 at TSS, SSP and SPs.

6.2.10 Automatic Fault Locators at TSS, SSP and SPs, with accuracy within ± 450 meter (3% or better inter distance between TSS-SSP, SSP-SP), shall be provided.

6.2.11 The Power supply system shall be monitored and controlled through a SCADA system installed at a Centralised Operation & Control Center and associated Control, monitoring & sensing equipment at TSS, SSP and SPs including the equipment level Fault Diagnostic as required.

6.3 DESIGN OF EARTH SYSTEM

(1) System protective earthing for providing electrical safety on entire system including earthing of non-current carrying metallic components, cable supports, transformer neutrals, lightning arrestors, etc. shall be designed. The earthing system shall conform to IEEE80: 2013, EN 50122-1 and EN — 50522, IS 3043 —1987, and Earthing Manual 131 Issued by CBIP in that order of priority as applicable.

(2) The earth system shall consist of: -

(a) Earth Mats and Earthing Systems in Traction Substations,

(b) Earth Mat System in Sub-Sectioning Posts,

(c) Earth Mat System in Sectioning and Paralleling Posts,

(d) Earth Mat Systems at Auto Transformer Stations,

(e) Buried earth conductors (BEC, if required) of appropriate size along the track alignment as per the scheme shown in Part-2, Section VII-3: Tender Drawings,

(f) Isolators with earthing heels as required,

(g) Earth for Auxiliary Transformers,

(h) Buried rail and its connection,

(i) Earthing of Neutral section,

(j) Aerial Earth Wire (AEW) of appropriate size along the track alignment as per the scheme shown in Part-2,Section VII Volume 3 : Tender Drawings Documents,

(k) OHE Structure Bond & Rail Continuity and Cross Bonding,

(l) Bonding and earthing, equipment earthing and working platforms to limit the step and touch potential of Equipment's working platform,

(m) Earthing of bridges (FOB, ROB etc.), Station Canopy, Service Building in proximity and Trackside structure in conformance to EN50122-1,

(n) Independent earthing/ satellite earth mat to limit the step and touch potential.

(3) The Contractor shall carry out design study of the earthing system on the basis of safety to public, the operator and maintenance personnel against touch and step potential & fire hazards and finalise the design, sizes and layout of main earth conductors, taking into account of adjacent 25kV system also.

(4) In all traction power supply control posts, copper cladded steel rods, GI flats and GI pipes, allowing adequate margin against corrosion shall be used as per EN-50522 / IS 3043 in that order of priority as applicable and manual on sub stations issued by Central Board of Irrigation and Power (CPIB). The earth rods below the mat shall be copper clad steel as per IEEE80/IEC62561-2/ANSI/NIMA Gr-.1-2007/EN50522-2. All the Earth mat joints shall be exothermic as per the requirements of IEEE80:2013. The connections shall be maintenance free, self-gripping type. Wherever the earthing bonds pass along or across the tracks, it shall be routed along the sleepers using proper fasteners and clamps / exothermic joint so as to avoid damages/ disconnection during ballast screening or tie-tamping of the track.

(5) The Earthing system provided at TSS, SSP and SP shall include Earth Mat system designed in conformance to IEEE 80: 2013. The maximum earth resistance of entire System shall meet the following requirements:

Table 6.3.1Maximum Earth Resistance

Location	Total earth system resistance (OHMS)
TSS	0.5
SSP	2.0
SP	2.0
Auxiliary Transformer station	10.0
Other locations	To meet the requirements of EN50122-1

6.4 LIGHTNING ARRESTERS

6.4.1 Lightning arresters shall be installed at each location of TSS, SP, SSP, SS and ATs. All auxiliary transformers shall have provision of spark gap as per RDSO's latest instructions.

6.4.2 Each lightning arrester shall incorporate an individual earth, which shall be connected to a ground rod or rods and shall also be connected to the earth system in vicinity.

6.4.3 Each earth connection shall have earth resistance as specified by the lightning arrester manufacturer for the type of unit supplied and shall be tested individually in accordance with testing procedures as approved by the Engineer.

6.4.4 Bonding cable connections between the Lightning arresters and the OHE, and between the Lightning arrester and the grounding system, shall be installed with a minimum number of bends.

6.4.5 The connection of lightning arresters to OHE shall be such that in case of breakage of the lightning arrester, the connector does not create an earth fault in the OHE.

6.4.6 Lightning arresters shall be provided with leakage current monitor and surge counters for monitoring.

6.4.7 In compliance to RDSO's Maintenance Instruction No. TI/MI/0048, the Lightning Arrester shall be provided with Dis-connector assembly along with Telltale Sign so as to enable faster identification and isolation, if required, and consented by the Engineer.

6.4.8 Lightning Protection

(1) The entire sub-station shall be protected against lightning strikes by providing earth screen conductors on tower peaks and/or by means of lightning protection masts suitably spaced to cover the entire area.

(2) The height and locations of the lightning masts shall be designed appropriately with due consideration to the equipment layout in the TSS/SSP/SP, to ensure that all the equipment required to be protected against lightning are within protective zone provided by the lightning conductor.

(3) The lightning conductor shall consist of ;

(a) Lightning receiver projecting above the object to be protected;

(b) The earthing grid;

(c) The conductor which connects the receiver with the earthing grid and is meant to carry the lightning current away safely to the ground.

(4) The contractor shall furnish a calculation for the Direct Stroke Lightning Protection system for TSS/SSP/SP and ensure that all the equipment remain protected from

Direct Stroke lightning the lightning protection designs shall provide a failsafe protection to the TSS/SSP/SP building and switchyard.

(5) Lightning protection shall conform to IEEE 998, IEC 62305 and IEC 62561 as applicable.

6.5 SHORT CIRCUIT CAPACITY

The Contractor shall ensure that traction substation and auxiliary power supply system including cables installed shall be capable of withstanding the Power Supply utilities PGCIL/DISCOM's transmission line fault levels at the points of common coupling and downstream with an allowance to cater for possible future increases. The fault levels to be catered for are given in Table-6.5.1 below:

Table 6.5.1: Design Short Circuit Levels

System Voltage kV	Fault level in kA	Fault Duration in seconds
220	40	1
132	30	1
25	12	3

Specific requirements (wherever they are different) are furnished in the equipment/sub-system specifications. The Contractor shall carryout the load flow and short circuit study of the 2x25kV distribution network and adopt the short Circuit level as stringent which may be witnessed in any stringent fault Scenario. Nevertheless the Fault level at OHE shall not be taken less than 12kA for calculations. The short circuit apparent power of the system shall be conforming to EN-60076-5 (Table-2)

6.6 EHV POWER SUPPLY DESIGN DATA

6.6.1 Insulation Coordination

(1) The nominal voltages and corresponding maximum voltages shall be as follows:-

Nominal Voltage	Maximum Voltage
220kV	245kV
132kV	145kV
25kV	29kV
240V	250V

(2) The 220 kV AC, 132kV AC and 240V AC equipment shall meet the Insulation coordination requirements of EN50124-1 or IS 2165 (Part I and Part II) with latest amendments as stringent.

(3) 25kV ac equipment shall have Insulation levels according to the EN 50124, Railway Applications – Insulation co-ordination.

(4) 2x25kV switchgears connected with out of phase power supplies of 180 Degree apart, the rated voltage will be minimum 60kV.

6.7 POWER QUALITY(PQ)

6.7.1 Contractor shall ensure the Power Quality, keeping the voltage and current unbalance, reactive power and harmonic contents, within the prescribed limit of state power utility in normal and extended feed conditions throughout the designed life of the equipment. For connectivity to the grid sub-station of power supply authorities, following power quality limits have been laid down at the point of common coupling (PCC), the contractor shall Control the Power quality within the applicable limits by providing the necessary PQ Improvement equipment. Point of Common Coupling (PCC) shall be the 220kV/132kV gantry in HORC Substation (inside the TSS boundary) where the transmission line of state power authority is terminated.

6.7.2 Voltage unbalance

The limit of voltage unbalance permitted according to Central Electricity Authority (CEA) standards are as follows:

Voltage of supply	Maximum permissible unbalance
132 kV	3%
220 kV	2%

6.7.3 Harmonics Generated at the PCC

The contractor shall carryout the Harmonic Study and Provide the Mitigation equipment to limit the Harmonics within prescribed limits as per guidelines issued by Central Electricity Authority (CEA) of India as given in table below.

Harmonics generated	132kV system	220kV system
THD for voltage	Not more than 5%	Not more than 2.5%
Any individual harmonic	Not more than 3%	Not more than 2%
THD for current	Not more than 8%	as per IEEE STD-519:1992

6.7.4 Assuming an Initial demand of 30MVA, the Contractor shall install power factor correction device to improve power factor from 0.85 to 0.95 by installing 50 % static and 50 % variable capacitors or 100% Variable capacitors (without permitting to go in leading power factor) capable of up-gradation when full load of 60/84/100MVA materialises in future.

6.7.5 The design of 12000 HP locomotives is planned to limit the harmonics specified in the table below for stages of operation of 100 % down to 50% working in a train. However, for the existing locomotives on IR harmonics measurement shall be carried out for thepurpose of design.

S. No.	Interference current	Limit
1	Psophometric current	10.0 A
2	DC component	4.7 A
3	Second Harmonic Component (100 Hz) and 83.33 Hz component	8.5 A
4	1400 Hz up to 5000 Hz	400mA

6.7.6 The Contractor shall prepare a detailed document on power quality and obtain prior approval of the same from Engineer.

6.8 SWITCHGEAR AND PANELS

6.8.1 All switchgear and panels shall be vermin proof, constructed from mild steel finished with powder coating by seven tank processes. The proposed colours shall be submitted for review by Engineer. Anti-condensation heaters shall be supplied where necessary. Ingress Protection Class at a minimum shall be IP 65 for outdoor installations and IP 54 for indoor installations.

6.8.2 The switchgear shall be designed motorised, draw out type such that a failed circuit breaker/ interrupter can be taken out and replaced within MTTR of 4 hour maintenance period.

6.8.3 Switchgear shall have appropriate terminations to suit the locations and electrical clearances. Where the size of available gland/ terminations is small the Contractor shall use cable box terminations to maximize the electrical clearances to the operationalrailway.

6.9 PROTECTION SCHEME

6.9.1 The Contractor shall define the Monitoring, control & Protection philosophy and furnish a scheme of protection with fast discrimination and reliable operation based on latest state-of-the-art computerised logic protection scheme. All types of faults on overhead equipment covering faults among conductors for 25 kV feeder, OHE, and earth shall be identified, to facilitate isolation and location (within ± 450 m accuracy) and fault locator differential protection for transformer and the distance protection with at least threezones with back up protection shall be provided for feeders. The traction switchgear and cables / feeders on supply side and the catenary on HORC side must have sufficient protection. It shall have over current protection for traction transformers with inverse definite time relays set to the rated load, earth fault protection, Buchhloz relays, winding and coolant temperature detection under normal and extended feed condition.

6.9.2 The impact of trains with regeneration shall be taken by the Contractor while designing protection scheme. Definite time over-current and back up over current shall be provided. Breaker re-closing facility shall be provided and after first re-closure on the persistence of fault, breaker shall not be closed. Detailed scheme shall be put up for approval of the Engineer at design stage.

6.9.3 The scheme of protection shall be fully coordinated with the Power Supply Authorities.

6.9.4 The Contractor shall submit detailed fault calculations, relay settings and fault co-ordinated curves showing proper protection, discrimination between all upstream and downstream equipment.

6.9.5 All protection functions available in the manufacturer's specifications shall be available for use of the Employer, without having to purchase any passwords or unlocking codes. Any such passwords or unlock codes shall be available to the Employer free of cost during or post contract.

6.9.6 The Contractor shall design protection system for power supply equipment to ensure:

(1) Adequate coordination with the Power Supply Authorities/Indian Railway.

(2) Adequate discrimination between load and fault conditions under normal and extended feed condition.

(3) Adequate, required type of monitoring, control & protection system including the Protection relays, Control Relay panel and CTs / PTs etc.;

6.9.7 All the relays employed for the protection of the system shall be numerical type conforming to IEC – 60255 or RDSO specifications, wherever applicable

6.9.8 The protection scheme shall meet to the requirements of EN 60076, EN 50119, IE Rules and ACTM and include the following protections as minimum but not limited to:

(a) 220kV/132kV Transmission Line Protection as required

- Under Voltage
- Over current protection instantaneous and with time delay
- Line Distance Protection

(b) 220kV/132kV Bus coupler protection in TSS:

- Backup over current protection both instantaneous and time delayed
- Bus differential Protection

(c) 220kV/132kV Traction Transformer Protection

- Over current Instantaneous / IDMT
- Restricted Earth fault (REF)
- Differential Protection
- Internal faults Buchholz,
- Oil Temperature Indicator (OTI) & Alarm (H/L) and Oil Temperature Trip (H)
- Winding Temperature Indicator (WTI) & Alarm (H/L) and Winding temperature Trip(H),
- Low Oil Level Alarm
- Transformer Tank Earth Protection

(d) 55/ 2x25kV LV side Transformer Protection:

- Over current Instantaneous / Inverse Definite Minimum Time (IDMT)
- Differential Protection

(e) 55/ 2x25kV Bus Bar protection system

- Under Voltage Relay

(f) 55/ 2x25kVFeeding Bay Breakers

- Over current Instantaneous / IDMT
- Distance Protection
- Under Voltage Relay

(g) Auto Transformer Protection

- Over current Instantaneous / IDMT
- Restricted Earth fault (REF)
- Differential Protection
- Internal faults Buchholz,
- OTI & Alarm (H/L) and Oil Temperature Trip (H)
- WTI & Alarm (H/L) and Winding temperature Trip(H),

- Low Oil Level Alarm

(h) Feeder Protection

- Feeder Distance Protection (as applicable to SP)

6.9.9 Disturbance, event recording shall be built in feature and shall be included in the IED (Intelligent Electronic Devices), MFM (multi- function meters) including Data exchange with HMI (Human Machine Interface) and PC. The relays, IEDs, MFMs shall be provided with Suitable communication interface conforming to IEC 61850 standards.

6.10 GALVANISATION OF ALL OUTDOOR STEEL WORKS

(1) Steel structures for outdoor TSS, SSP, SP, SS and those required for support of overhead equipment, all Small Parts Steel (SPS) works, earthing flats/pipes/rods etc shall be hot dip galvanised as per RDSO's specifications no. ETI/OHE/13 (4/84 or latest) i.e. minimum coating of zinc shall be 610 gm/m^2, except for marine and chemically polluted areas. The zinc coating specified in the equipment specification, if any, will also be considered and most stringent zinc coating out of the two will be applicable as approved by the Engineer. The Contractor shall carryout the Pollution Mapping of the entire section as per the relevant standards and RDSO guidelines and shall be submitted for approval of The Engineer. The polluted areas as identified as a result of pollution mapping by the contractor and approved by the Engineer shall be provided with the zinc coating of minimum 1000 gm/ m^2 on Steel structures. In case of need to use nonstandard SPS at special locations to be fixed to the steel structure, these shall be with clamps to avoid drilling of galvanized mast sections.

(2) The galvanisation shall be done only after cutting and drilling work is over. Galvanised bolts, nuts and spring washers shall be used for assembly work.

(3) Wherever galvanising on ferrous components has been damaged in handling, the same shall be given two coats of zinc chromate primer and two coats of aluminium paints conforming to IS 2339 only after examination and "No Objection" from the Engineer. However, the Engineer shall reserve the right to ask any item hot dip galvanized again if he finds the galvanisation damage extensive.

(4) All the ferrous materials used in SYS-1 works shall be galvanized.

6.11 MODULAR EQUIPMENT AND COMPONENTS

6.11.1 All components shall be modular, in construction to facilitate easy troubleshooting and replacement of components to minimize down time of the system. Design of components shall be such that it facilitates high level of interchangeability of components i.e. same size of nut bolts, number of fittings of similar type in design, shape & size as much as possible.

6.11.2 Equipment shall be selected from a common palette of materials to ensure that equipment is interchangeable between sites and spares & training requirement on different equipment and systems is kept to a minimum.

6.12 OUTDOOR SWITCHYARD FOR TSS

The layout shall be designed and constructed based on CBIP/RDSO guideline as applicable and other requirements specified in this PS.

6.13 ELECTROMAGNETIC COMPATIBILITY (EMC) REQUIREMENTS

6.13.1 General

The requirements stated below shall be read in conjunction with the EMC Requirements in the General Specifications.

(1) All the Traction system equipment are expected to function satisfactorily in the environment of 220kV/132 kV, High Rise 2x25 kV, 25kV as they may be subjected to and designed to withstand all the High Voltage surges and Power variations. The Contractor shall assess and quantify the impact of EMI (Electro Magnetic Interference) and prepare an EMC Management Plan for EMI as may be witnessed in the 2x25kV environment. The EMC Plan shall also include the impact of EMI in tunnel also as 11kV/440V AC cables shall be in the tunnel for general power supply and lighting system.

(2) An EMC Management Plan shall be submitted for review by Engineer.

(3) The EMC Management Plan shall include measures to reduce conducted, induced, and radiated emissions, especially the levels of harmonic, to acceptable values as specified by the relevant international standards.

(4) The plan shall analyse EMI/EMC impacts of the design of the Traction system on all other train-borne equipment and trackside equipment as well as the general environment. Particular attention shall be paid to additional requirements in grounding, bonding, and shielding, filtering, and cabling arrangements.

(5) The Contractor shall conduct type tests as well as full EMC tests. Tests to be conducted shall include but not limited to the following standards:

(a) Overall compliance:

EN50121-1	Railway Applications Electromagnetic Compatibility – General
EN50121-2	Railway Applications Electromagnetic Compatibility – Emissions of the whole railway system to the outside World
EN50121-5	Railway Applications – Electromagnetic Compatibility - Emissions and immunity of fixed power supply installations and apparatus.
EN50152	Railways Applications — Fixed Installations — Particular requirements for ac switchgear. (All parts)

(b) Specific Standards

(i) Immunity

IEC 61000-4-2	Electrostatic discharge
IEC 61000-4-3	Radio frequency fields
IEC 61000-4-8	Power frequency magnetic field
IEC 61000-4-9	Pulse magnetic field
IEC 61000-4-10	Damped oscillatory magnetic field

(ii) Emission

IEC61000-4-6	Radiated emission
IEC61000-4-16	Conducted emission
IEC61000-2-6	Electromagnetic Compatibility Part 2: Environmental Section 6: Assessment of the emission levels in the power supply of industrial plants as regards low-frequency conducted disturbances.
IEC61000-3-2	Electromagnetic Compatibility Part 3: Limits for harmonic current emissions.
IEC61000-3-3	Electromagnetic Compatibility Part 3: Limits Section 2: Limitation of voltage fluctuations and flicker in low-voltage supply for equipment with rated current 16A.
IEC61000-3-5	Electromagnetic Compatibility Part 3: Limits Section 2: Limitation of voltage fluctuations and flicker in low-voltage supply for equipment with rated current greater than 16A.

(6) The Contractor shall identify all EMC tests to be undertaken in the EMC Management Plan and where appropriate in the integration testing plan to demonstrate the level of EMC achieved. The test plan shall make clear the pass / fail criteria prior to any testing taking place identifying the acceptable limits, conforming standard and achieved results. All tests shall be conducted at severity levels specified by EN50121. The test plans shall be approved by the Engineer prior to any testing being undertaken.

6.13.2 Intra-system EMC

The Contractor shall ensure that all intra-system EMI are taken care of through proper design and other special measures. All major sub-systems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipment operating in railway or similar industrial environment.

(1) The Contractor shall ensure that all equipment is designed and constructed in accordance with the latest issues or versions of internationally recognized EMC standards, including but not limited to, EN50121 series and IEC61000 series to ensure proper functioning. All applicable standards shall be identified in the EMC Control Plan.

(2) The Contractor shall also provide computations on the expected conducted and radiated emissions from the power supply system due to electrical fault, load fluctuations, and/or system imbalance. Their effects on the safety-relatedequipment, especially the probabilities of leading to an unsafe operation shall be determined. An appropriate document for safety audit shall be maintained by the contractor to demonstrate EMC compliance.

6.13.3 Non-safety-related systems interference

(1) The Contractor shall take appropriate measures to ensure that EMC is achieved between the power supply equipment and all other system equipment. The transformer shall be designed with particular attention to the suppression of

harmonic voltages, especially the third and fifth, or any other values as specified in the latest version of the EN 50121 series and other relevant International Standards.

(2) All radiated emissions, either via the power cables, transformers or any other system components shall be minimised such that they conform to the appropriate international standards. Special reference shall be made to the compliance of EN50121 and IEC61000.

(3) All power cables shall be properly shielded where applicable. Reference shall be made to IEC61000.

(4) The Contractor shall ensure that all conducted emissions, including but not limited to harmonics, shall not interfere with telephone, communications, supervisory and control, train protection and control, and other railway equipment via the 25kV AT systems. Reference shall be made to EN50121-5 and IEC61000.

(5) The Contractor shall also co-ordinate with other contractor/ Agencies whose equipment are connected to the power supply system and are likely to inject unwanted emissions into the power supply system to reduce such emissions. Reference shall be made to EN 50121 and IEC61000 series.

6.13.4 Environment EMC

The Contractor shall ensure that radiated emissions from the power supply cable are maintained at an internationally acceptable level. The Contractor shall also ensure that the power cables are protected from RF radiations from all telephone network operators and radio networks.

6.13.5 Installation and Mitigation Guidelines

IEC 61000-part 5 -6 series of guidelines on mitigation of external EM influences shall be observed wherever applicable.

6.13.6 Earthing

(1) The Contractor shall prepare an Earthing & Bonding Management Plan which shall detail the approach for delivering an integrated earthing scheme covering all the systems, service buildings and DFCCIL/Indian Railways in proximity. This shall be submitted to the Engineer for approval. This plan shall apply to the Permanent Works by all the Other Contractors/ Agencies on the Project to ensure the structures and equipment are safe from EMI due to 220/132/2x25 kV traction system effects and for touch voltages and shall form an important interface requirements for the project.

(2) Earthing system shall be designed to ensure personnel safety and protection of persons and installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances.

(3) The contractor shall update the Earthing and Bonding Plan to reflect any consequential changes. This plan shall be the basis of design for all earthing and bonding on Traction system, OHE and SCADA infrastructure.

6.13.7 Bonding

(1) Bonding of all exposed metallic parts of all equipment supplied by the contractor shall be under the scope of work including connecting them to the earthing network.

(2) Direct bonding shall be used wherever practical. Where indirect bonding via bonding strap is used to connect two isolated items, the bond shall satisfy the following minimum requirements and prevailing international standards, IEC61000 and EN 50122.

(a) Low bonding resistance from DC to at least 2 GHz.

(b) Low bonding inductance from DC to at least 2 GHz.

(c) Proper bonding procedure, including appropriate surface treatment before and after the bonding process, is adopted.

(d) Proper use of bond material to minimise electrolytic corrosion.

6.13.8 Cabling

(1) The cables used shall be adequately protected against external interference. Additional protective measures, including but not limited to the use of metallic conduit, armour, screening conductors, ferrite choke, and EMI filters shall be used to reduce such external interference wherever required. Covered conduit is preferred.

(2) A cable routing plan shall be designed to minimise likelihood of coupling between parallel cables. The Contractor shall refer to guidelines recommended by IEC61000.

Table: 6.13.9 Immunity levels at various power ports

Enclosure port	
Test	**Severity level**
RF field	800-1000 MHz, 20 V/m, 80%AM 1kHz
RF field - pulse modulated	900 MHz, 20 V/m, 50% duty cycle, PRF 200 Hz
Power frequency magnetic field	50 Hz, 100 A/m
Electrostatic discharge	6 kV contact, 8 kV air
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHzsource impedance 150 ohms
Fast transients	2 kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz

Port for process, measurement & control lines, and long bus & control lines	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHz source impedance 150 ohms
Fast transients	4 kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	1.2/50 Tr/Th□sec, 2 KV (c), 1 kV (d)
Power frequency	150 Vrms
Power frequency common mode	650 V rms

DC input and DC output power ports	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80% AM at 1KHz source impedance 150 ohms
Fast transients	4kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	1.2/50 Tr/Th□sec, 2 kV (c), 1 kV (d)

AC input and AC output ports	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHz source impedance 150 ohms
Fast transients	4 kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	2/50 Tr/Th□sec, 2 kV (c), 1 kV (d)

Earth port	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHzsource impedance 150 ohms

6.13.9 Bonding of conduits & cable armour

Proper bonding & cross bonding of metallic conduits armour & screening conductor shall be made to ensure that the induced voltage in them during fault conditions are within safe limits.

(End of Chapter 6)

CHAPTER 7 - POWER SUPPLY CONTROL POSTS AND DETAILS OF EQUIPMENT

7.1 GENERAL

7.1.1 Traction Power Supply System Works include following installations: - Two (2) Traction Sub-Stations (TSSs); Three (3) — 2x25 kV Sectioning and Paralleling Posts (SPs); Two (2) – 1x25 kV Sectioning Posts (SPs); Seven (5) — Sub-Sectioning Posts (SSPs). The Contractor shall make his own General Traction Supply Diagram based on the details of locations of TSS and traction supply posts as shown in the Part-2,Section VII Volume 3 : Tender Drawings of the Tender document.

7.1.2 Land has been acquired for TSSs, SSPs and SPs Power Supply Control Posts as shown in the Table 7.1.1, 7.1.2 and 7.1.3. The Contractor shall adopt the layout and design of equipment and appropriate Modular technology to reduce the footprint to accommodate TSS/SP/SSP within allocated land in the ROW maintaining the required Electrical Clearances and without compromising any performance requirement. The status of availability of land for the Supply Control Posts is as follows:

(1) The locations of TSS have been finalized. The Contractor shall locate the Feeding overlap suitably as per the TSS location and the limitations if any due to track geometry or the STOP Signal locations.

(2) In regard to SSP/SPs, the required land has been identified, The Insulated overlap/Neutral Section locations may also need a review with respect to SSP/SP location and the limitations if any due to track geometry or the STOP Signal locations as stated above and accordingly manage the SSP/SP Equipment as per modular layout in the acquired land running the feeders till overlap/neutral section.

(3) At some locations, the provision of neutral section on the OHE opposite of the TSS and SP may not be practicable in view of these being too close to a stop signal ora restrictive aspect signal for a locomotive to permit coasting through the neutral section without the risk of being stalled. Accordingly, the neutral section will have to be suitably located away to a suitable location with feeders being run within the ROW.

(4) Sectioning Switches (motorized isolators) shall be provided for mainline appropriately placed, at stations to permit receiving & despatch of the Trains and isolating the faulty section ahead and limit the length of faulty sections. The Contractor shall make his own General Supply Diagram with Sectioning Arrangement included in the Part-2,Section VII Volume 3 : Tender Drawings of the bidding document.

7.1.3 In regard to SSPs, the General Power Supply diagram provides for appropriate sectioning, so as to permit trains to take alternative paths through stations during traffic and power blocks minimizing traffic delays. Table 7.1.3 indicates the tentative location of the SSPs based on Sectioning Arrangements. The Contractor should consider all these locations and prepare his own designs to provide the best sectioning of the overhead equipment for ease in maintenance and operation. Insulated Overlap (IOL) is generally, located in front of SSP. However, the location of Insulated Overlap is also based on location of STOP signals and in consideration of adequate distance, required to be located away from SSPs and may, therefore, call for running feeders for feed to OHE from SSPs.

7.1.4 The proposal for final designs of General Supply Diagram clearly indicating the type of Post being provided at each of the location, may be made to the Engineer for his approval.

Table 7.1.1 List of Proposed Traction Substations (TSS)

S. No	Installation Name	Approx. HORC Chainage (in Km)	Plot Size(sqm) (metre x metre) Approx.	Voltage level at point ofSupply/TSS
1	Chandla Dungerwas	43.270	140 x 85	220/132 kV
2	Mandothi TSS	90.000	140 X 85	220/132 kV

*__Note:__

Location and feeding zone TSS in adjoining phases may be considered for simulation study input data.

Table 7.1.2 List of Proposed Sectioning Post (SP)

S. No	Installation Name	Approx. HORC Chainage (inkm)	Available Plot Size (metre x metre) Approx.	SP Type
1	Prithla SP	(-)1.00	50x30	2x25 kV
2	Badsa SP	64.750	50x30	2x25 kV
3	New Harsana Kalan SP	124.130	50x30	2x25kV
4	Sultanpur SP	13.800 (IR chainage)	22x10 (Interface with IR)	1x25 kV
5.	Asaudah SP	36 (IR chainage)	22x10 (interface with IR)	1x25 kV
6	Patli SP	48.580 (IR chainage)	Under construction by another OHE contractor . (interface with IR and contractor MSIL(OHE)	1x25 kV

Table 7.1.3 List of Proposed Sub Sectioning Posts (SSP) (Mid-Section)

SN	Installation Name	Approx. HORC Chainage (inKm)	Available Plot Size (sqm) (metre x metrte) approx.
1	Sohna SSP	14.570	50x30
2	Dhulawat SSP	31.770	50X30
3	Manesar SSP	52.890	50X30
4	Badli SSP	75.830	50X30
5	Jasaur Kheri SSP	101.220	50X30

(1) The location of supply control posts shown in the tables above are based on the indicative alignment. The contractor shall prepare his own General Supply diagram based on the final Alignment Plan for the construction Designs and Drawings. The contractor shall accommodate the installations within the available land following the norms specified in relevant standards.

(2) There is provision of insulated overlap (IOL) for main lines. The IOL's location may also require short lengths of feeder wire to be run between SSP andcorresponding IOL.

(3) Names and chainages are indicative and may change. The Same shall be confirmed through field survey while design.

(4) The Contractor shall design the Equipment as per the feeding zone and actual location of TSS/SSP/SP.

(5) The land area for TSS/SP/SSP is approximate and dimensions may vary. Contractor shall provide boundary wall, fencing and other civil works on the entire land handed over to the Contractor.

7.2 EXTRA HIGH VOLTAGE POWER SUPPLY TO TSS

7.2.1 The Contractor shall provide all requirements for EHV Line Termination at the TSS to enable the Power Supply Authorities to complete their work and release power supply.

7.2.2 The Point of Interface between the State Power Supply Authorities (PSA) for 220/132kV, 3-phase, double circuit transmission line and the Contractor will be at the TSS's EHV Incomer Gantry, provided by theContractor. The Gantry will be provided by the Contractor as per the Transmission line Termination requirement of PSA as well as the TSS. PSA will terminate the transmission line at the gantry. All the Metering bay structures, foundations and equipment after the point of interface towards the TSS shall be provided by the contractor Package-SYS-1.

7.2.3 Check Metering Equipment including all associated metering class CTs and PTs for measuring power consumption shall be installed by the contractor on the incoming supply side of 220/132 kV.

7.3 220kV/132/2x25kV TRACTION TRANSFORMERS

7.3.1 The indicative typical TSS conceptual Scheme Diagram and layout are attached in Part-2, Section VII Volume 3: Tender Drawings. The Scott — connected traction transformers shall be manufactured and supplied as per typical specifications furnished in Chapter-19, Appendix-8 of these specifications.

7.3.2 Traction Transformer's minimum ratings are as follows. However, these are to be confirmed by the system simulation study by the Contractor and subject to the approval of the Engineer:-

Table 7.3.2

Salient Features of Scott connected Traction Transformers

Sr.	Parameter	Rating
1	Power Rating (MVA)	60 (Minimum) (ONAN) / 84 (ONAF) / 100(OFAF) MVA as per General arrangement as referred in Part-2, Section VII Volume 3 : Tender Drawings
2	Cooling	ONAN / ONAF/ OFAF
3	Connection type*	Scott Connected type
4	Rated secondary voltage	55kV/ 2x27.5 kV
5	Rated Primary voltage Un	220/132 kV
6	Highest system voltage Um	245/145 kV
7	Non-cumulative overload capacity after the Traction transformer has reached steady temperature on continuous operation at rated power	150% rated load for 15 min 200% rated load for 5 min

NOTE:*The voltage unbalance level shall be within the limit prescribed in Clause 6.7.2 of this specification at Rated Capacity including the overload condition.

(1) The Traction transformer(s) shall be designed for ONAN/ONAF/OFAF application duty requirement at stringent boundary conditions. The Traction transformer(s) shall be modularly designed so that they can be delivered by rail as well as by road. The Traction transformer shall be designed such that it is within IR SOD for HORC. Radiators, accessories and conservators shall be removable for transport through road / train. The Insulation oil may be removed for transport and a nitrogen cushion employed during transportation. Further, the design shall incorporate provision of ONAF/OFAF for indicative capacity of 84/100 MVA. All the cable works for control and monitoring of the fans and pumps shall be providedby the contractor. The fan motor and pumps shall be operated on single phase AC supply at 230 or 240 V.

(2) Traction transformers shall be supplied complete with pumps, fans and other accessories etc. The Capacity of all the Traction transformers shall be demonstrated by the Contractor for ONAN, ONAF and OFAF ratings during FAT. Contractor shall demonstrate the capacity of Traction Transformers on full load based on the OFAF at site simulated conditions, as desired by the Engineer.

(3) The transformers shall be installed on a suitable foundation that can withstand the transformers static and dynamic load. The foundation shall be able to support the loads during installation and removal.

(4) The substation transformer bays shall be provided with suitable pulling eyes to allow the transformer to be moved and positioned.

(5) Each transformer shall be located in its own bund (liquid containment). The bund shall contain stone metal soaking pits with voids of capacity adequate to contain at least 110% of total quantity of oil.

(6) The oil drums shall be stored on their own bund to prevent spillage. The bunds used for oil storage barrels shall be positioned so that they do not get filled with rain water.

(7) Outdoor oil-insulated transformers shall be separated from each other by fire walls for the purpose of limiting the damage and potential spread of fire froma transformer failure. There shall be a Fire wall between adjacent transformers. Fire wall shall

comply with NFPA 221, NFPA 851, IE rules andIndian Standards as per application duty requirement. The wall shall be sufficientto protect adjacent transformers in the event of a catastrophic failure/fire of one of the traction transformers. Fire wall shall be rated for minimum of 4 hour fire rating, the height and length of firewall conforming to IE rules, NFPA 221, 251, 850/851 and designed to withstand the effects of projectiles from exploding transformer bushings or lightning arresters to prevent spread of fire. Firewall provided between transformers should extend at least 30 cm above the top of the transformer casing and oil conservator tank and at least 60 cm beyond the width of the transformer and cooling radiators on either side. The contractor shall calculate the fire load, fire Plume height and fire plume temperature, effect of wind velocity on plume including the forces due to blast if any and demonstrate the adequacy of Fire wall withstand capacity as supported by a calculation or fire modelling.

(8) The Transformers shall be provided with fire detection alarm and protection system as per CEA (Technical standards for construction of electrical plants and electrical lines) regulations 2010.

(9) The Transformer's noise shall be tested in conformance to IEC60076-10 and shall not exceed 75dB at 1000 mm distance from transformer body. In urban areas, the traction transformers shall be enclosed in acoustic barriers where the operational noise contravenes the requirements of the "The Noise Pollution Regulation and Control Rules, 2000 or later".

(10) The design of the substation layout shall be such that one transformer can be removed by road without disturbing the operation of the HORC.

(11) The safety provision shall comply with section - 44 of Central Electricity Regulation – 2010 or as revised (measures relating to safety and electricity supply) and CBIP guidelines.

(12) The full load efficiency of the traction transformer shall be same or better (as 60 MVA ONAN) if a higher rating is offered by the contractor.

(13) If higher rating transformer is offered then the ONAF and OFAF rating shall be in the same ratio as that of 60/ 84/ 100 MVA transformer.

(14) The contractor shall comply with the requirements of IEEE Std 519:1992, where such limits are not specified by CEA. As specified in IEEE Std 519:1992,when the harmonic current flowing through the transformer is more than the design level of 5% of the rated current, the heating effect in the transformer should be evaluated. This evaluation will ensure that the transformer insulation is not being stressed beyond design limits.

(15) Scott Connected type connection type arrangement provided by the Contractor shall have minimum 3 years proven & satisfactory performance on any AC Traction System.

7.4 AUTO TRANSFORMERS

7.4.1 The Contractor shall supply Auto Transformers as per RDSO Technical Specification No. TI/SPC/PSI/AUTOTR//1200 (effective from 02.02.2021) and specifications furnished in Chapter 19, Appendix-9 of these specifications in compliance to EN 60076-1 for Capacities and (required if any by simulation) higher than the minimum specified, shall get it approved from the Engineer (if RDSO specification is not available). The auto Transformers shall not be less than the minimum rating and short circuit capacity of auto transformers as per table below:

Auto transformer	TSS	SP, SSP
Rating	12.3 MVA (Minimum) ONAN	8 MVA (Minimum) ONAN
Short circuit Capacity	35 times	25 times

7.4.2 The Transformers shall be provided with fire detection alarm and protection system as per CEA (Technical standards for construction of electrical plants and electrical lines) regulations 2010.

7.4.3 The full load efficiency of the Auto transformer shall be same or better (12.3 MVA for TSS and 8MVA for SSP/SP). If a higher rating of Auto Transformer is required as per simulation study, the same shall be approved by the Engineer.

7.4.4 The Auto transformer capacity as indicated as above is minimum for inter-distance of about 10- 20 km between TSS and SSP or SSP and SP. The Auto transformers size shall be designed to meet maximum load requirement to address the contingency of one AT failure at any of the TSS/SSP/SP to cater the power requirement for actual inter- distance. However, the capacity of Auto transformer of SSP/SP shall be uniform and shall be capable of meeting the requirement of maximum Inter-distance. The capacity shall be assessed as per the stringent scenario of fully loaded train consist as per Train operation plan and provided as confirmed through simulation results and shall be provided higher if simulation results indicate a higher Capacity.

7.4.5 The Auto transformers shall be provided with Nitrogen Injection Fire Suppression system. Fire load/Nitrogen volume with rate of flow shall be calculated to ascertainadequacy of gas to quench the possible fire.

7.4.6 The Auto transformers shall be provided with necessary fire wall between two ATs on the lines of TSS as per applicable standards.

7.5 CIRCUIT BREAKERS

7.5.1 The Traction power supply installations shall be provided with suitably rated Circuit breakers at TSS, SSP and SP. Where gas is used as an Insulation medium, the circuit breaker shall be fitted with a pressure monitoring device that will detect the reduction in pressure and provide a signal via SCADA to the electrical control room.

7.5.2 The command and control signals shall enter the enclosure via pressure tight plug and sockets to provide simple and quick connection and disconnection.

7.5.3 Each circuit breaker shall have a control cabinet with an IP-65 Ingress protection.

7.5.4 The poles shall be able to be operated locally electrically or by a control handle manually from the local control cabinet.

7.5.5 The circuit breaker shall have the minimum of 3 normally open and 3 normally closed auxiliary contacts that are directly driven from the parts of the circuit breaker / interrupter.

7.5.6 25 kV circuit breakers / Interrupters shall be of vacuum type only.

7.5.7 The control cabinet shall be equipped with the following functions:-

(1) Local and remote operation switch;

(2) Open and close buttons;

(3) Open and close indications;

(4) Operations counter;

(5) Control indication monitor;

(6) Capacitor charge indicator.

7.6 BATTERIES AND CHARGERS

7.6.1 There shall be two Battery Banks and Two battery chargers at each 2x25kV TSS, SP and SSP stations of required capacity and rating. The Contractors shall furnish the Design calculations for Battery set and Battery charger.

7.6.2 There shall be only one Battery Bank and one battery charger at each 1x25kV SP at Sultanpur and Asaudah stations of required capacity and rating.

7.6.3 Each battery charger shall be capable of supporting the total substation 110V dc operational load.

7.6.4 Each Set of Battery bank shall support 110V dc loads for a minimum of 10 hours.

7.6.5 The designs of the low maintenance lead acid batteries and battery charger shall be prepared as per IEEE Std 485 and their capacities and ratings got approved by the Engineer:

7.6.6 The 110V battery charger shall be fed from the essential services distribution board that itself will be fed from substation auxiliary transformer.

7.6.7 The battery charger shall be located inside the control room. The Batteries shall be located in Battery room or compartment which is vented to outside air.

7.6.8 All equipment shall have at least two readily accessible separate earth terminals, which shall be identified by symbol of earth mark adjacent to the terminals.

7.7 CONTROL AND POWER CABLES

7.7.1 The cable containment system and run of various cables shall be designed so as to ensure minimum de-rating due to proximity of the other cables adjacent, in tiers and in same duct/ trench. The Cable containment shall conform to IEC 61537 and IS: 1255.

7.7.2 Power and Control cables shall be installed preferably in separate cable containments. The Power cables for 25kV & 55 kV shall be Copper conductor, XLPE insulated conforming to IS: 7098 part-3, IEC 60502-2 and tested to IEC 60840 including meeting the type tests requirement. Such HV power Cable shall be manufactured with appropriately sized conductor, formation, Non-hygroscopic Semi-conducting tape, Triple extruded XLPE insulation (semiconducting compound, XLPE followed by the semiconducting compound) with water blocking barrier, Metallic shielding/ screen, armour binder tape and ST-2 class PVC over sheath as per application duty requirement of directly buried cables in Ground. The contractor shall furnish the calculations for considering required thickness of insulation/ construction. All the directly buried cables shall have the cable pull pits/ Pull boxes at all turning at regular and at maximum pull length possible and cable trenches used for The Cable laying shall have the Removable Trench covers meeting the requirement of IEC 61537, IEEE525 and IS 1255.

7.7.3 All cable shall be suitable for the environmental conditions as per relevant chapter of this specification. Where cables are installed in trenches or ducts the cable shall be designed to function without any deterioration in fully immersed in water or Insulation oil.

7.7.4 Cables shall be indelibly marked regularly along their whole length with generally the following information:

(1) Manufacturer's name;

(2) Insulation material;

(3) Number of cores;

(4) Cable conductor size;

(5) Cable nominal voltage;

(6) Batch no.

(7) Year of manufacture;

(8) Country of origin;

(9) Conductor length (m).

7.7.5 Cable joints shall not be formed in ducts or trenches. Where joints are needed in duct or trenches separate joint bays shall be constructed.

7.7.6 All cables and ducts shall have identification plates fitted at the following locations as a minimum: -

(1) At all terminations,

(2) Every 30m along the length,

(3) At entries/exits through walls or obstructions,

(4) Entry and exits to ducts or trenches,

(5) At cable joints.

7.7.7 All cable joints shall be allocated cable joint numbers and each joint shall be physically labelled. The location and joint numbers shall be shown on the as built record Drawings.

7.7.8 25kV A.C. single core cables shall be armoured. All the cable entry points from yard to TSS / SP/ SSP's panel room shall be sealed with EPDM module with fire resistance as per UL 1479 for protection against vermin, rodents and damages.

7.7.9 Cable types required on the project have been indicated in table below, however, the same shall be verified for the performance required.

S. No.	Voltage		Duty	Core Material	Number of cores	Brief Description	Remarks
	Normal (kV)	Maximum (kV)					
2	25 AC	52.0 AC	Traction power	Copper Conductor cable for all sizes	Single Core	FRLS outer sheath armoured XLPE insulated	Cables laid in parallel as required by system design
3	3.3 AC return current	3.3 AC	Traction power return current	Copper Conductor cable for all sizes	Single Core	FRLS outer sheath, armoured XLPE insulated	-Do-
4	0.240 AC	1.1 AC	Power Supply to Equipment	Copper Conductor cable for all sizes	Double core	FRLS outer & inner sheath, Armoured PVC insulated	-Do-

S. No.	Voltage		Duty	Core Material	Number of cores	Brief Description	Remarks
	Normal (kV)	Maximum (kV)					
5	0.240 AC and 0.110 DC	1.1 AC	Protection and Control	Copper Conductor cable for all sizes	As required	FRLS HR PVC rated for 105 degree C	Cables laid in parallel as required by system design
6	0.240 AC and 0.110 DC	1.1 AC	Alarm & Emergency Circuits	Copper Conductor cable for all sizes	As required	PVC insulated Fire resistant rated 3 hours rated	-Do-

7.7.10 The cable design and installation shall conform to IEC 60502-1, IEC 60502-2, and IEC 60840 as per appropriate application duty and rated Voltage and IEC 61537, IS: 1255, and Fire Safety Regulations of National Building Code.

7.7.11 Compounds of additives to the cable over sheath shall be anti-termite and resistance and shall comply with internationally acceptable regulations.

7.8 CIVIL WORKS & ILLUMINATION AT TSS, SP, SSP and Tower Wagon Shed

7.8.1 The Contractor shall perform the Civil and Structural design including all calculations and preparation of Drawings, specifications and other documents but not limited to for the following:

(1) General arrangement (Layout and elevation),

(2) Earthwork,

(3) TSS/SSP/ SP control room Building,

(4) Structures and sub-structures for indoor equipment,

(5) Foundations (M-20 grade concrete) for all the major equipment including associated protection equipmentas planned for Main and Standby Transformers and organizing the layout accordingly to accommodate the future provisions and capacities of the equipment for double line section,

(6) Cable trenches with covers,

(7) Drainage (Covered type),

(8) Networks (Water Sewage etc.),

(9) Fire wall between the transformers,

(10) Transformer/ auto Transformer weight carrying Road in side TSS/SSP/SP,

(11) Boundary wall / Fencing.

(12) Tower Wagon shed with inspection pit.

7.8.2 The Contractor shall execute all the civil works and electrical works at TSS/SSP/SP and Tower Wagon Shed etc. as under but not limited to:

(1) Power supply Control rooms of TSS/SSP/SP, Tower Wagon Shed and Service buildings

(2) Gravel spreading (single sized aggregate of nominal size 20 mm) shall be minimum150mm as per requirements of IEEE-80-2013,

(3) The Top most level of the trench shall be finished not less than the plinth level and about 100mm above the Gravel level in the switching yards of the TSS, SSP, SP etc. to avoid spill over of the gravels in to open trench if any.

7.9 CONTROL ROOM, TOWER WAGON SHED AND YARD LIGHTING

7.9.1 Contractor shall design and construct the substation buildings for TSS, SSP, SP and Tower Wagon Shed and shall be responsible for land preparation, boundary wall, entrance gate, foundation, support anchor block, door, windows including architecture, civil, structural, drainage, plumbing, conduiting, wiring, provision of lights, fans, Exhaust fan etc. All such parts and accessories shall be deemed to be within the scope of specification whether specifically mentioned or not. The soil investigation for foundations for building work etc shall be undertaken and Engineer's approval shall be taken. Electrical resistivity of soil for designing safe grounding system shall be done. The site shall be fit to support the transportation of heavy equipment, including transformers whose weight may be in the range of 100-150 Tonnes or higher. In TSS, SP & SSP, Contractor shall provide a road & rail system integrated with transformer foundation to enable installation and the replacement of any failed unit . The Contractor shall take such rail road system to the adjoining approach road for easy transport of the transformers and heavy equipment through rail/road transport.

7.9.2 All buildings shall be provided with concealed GI Conduits for all wiring works. Building signages of LED type shall be designed and provided.

7.9.3 The functional and structural design of buildings shall conform to National Building Code. Load due to earthquake shall be assessed as per provisions of relevant IS Code with latest amendment.

7.9.4 The grade of concrete should be as per approved design and minimum M-25 as per IS 456 for all civil construction of buildings, cable trenches and precast removable RCC covers. The cement plaster shall be 1:4 (cement: sand) and brick class designation of less than 10 shall not be used. The site shall be cleared of all existing encumbrances, levelled and compacted. The earth compaction shall not be less than 95%. The finished ground level of substation site shall be above the highest flood level (HFL) in the region. The finish ground level shall be at least 600 mm above the main rail /road level near to the site.

7.9.5 The drainage of substation shall be provided as per best engineering practices to prevent surface flooding and pooling of water. Suitable drainage system and ground water recharge pit shall be made. Trenches shall be provided with suitable slope so that no water remains in the trench and all water is diverted to recharge pit. The trench beds shall have a slope of 1/500 along the run and 1/250 perpendicular to the run. The top of the trenches shall be kept at least 100 mm above the finished ground level. The top of cable trench shall be such that the surface rainwater does not enter the trench.

7.9.6 The ceiling height of the substation building shall be minimum 4.2 metre above floor level. The plinth of the substation building shall be 300 mm above the natural ground level of substation. All fencing items i.e., wire mesh, angles, flats etc shall be GI.

7.9.7 All windows of substation building shall be fitted with burglar bars firmly attached to the structure of building and shall be of an area about 20% of room floor area. The windows shall be of appropriate section and shall be fitted with locks. The windows shall be provided with minimum 5mm thick toughened glass. Doors and shutters shall be sturdy and having corrosion proof material. Continuous sunshade (minimum 500 mm) shall be provided on windows and doors to avoid of ingress of rain water. Storage space with doors and locking system shall be provided.

7.9.8 The battery room shall be provided with exhaust fan and acid resistant tiles on the floor and on the side walls upto height of 1.5 meter. The ceiling shall be painted with acid resistant paint.

7.9.9 Toilet rooms and water supply arrangement shall be made in the substation building along with provision of submersible pump. Water supply shall be available for 24 hours a day in TSS/SP/SSP buildings.

7.9.10 Substation building shall be provided necessary lighting and fans. The wiring conduits shall be concealed. The power points, AC points as required hall be provided. The wiring shall be with copper cables. Substation building shall be properly earthed against any lightning. Yard lighting with proper luminaires shall be done with proper cables and switching system.

7.9.11 The Contractor shall provide suitable pathways/roads to afford easy reach to equipment in the switchyard. A motorable road suitable for heavy equipment shall be provided to permit vehicle movement from switchyard heavy equipment up to control room of TSS/SP/SSP and from control room to Entry/exit gate(s). Motorable road for vehicle movement upto Tower Wagon Shed shall be constructed.

7.9.12 The Contractor shall provide roads within the TSS/SP/SSP of Reinforced Cement Concrete (RCC) to permit transportation of all heavy equipment. The roads shall have minimum 5 m wide RCC road. Road construction shall be as per IRC standards. For this purpose, the Contractor shall prepare the necessary design and calculations and submit them to the Engineer and shall construct roads as per approved designs.

7.9.13 Necessary trenches inside the building shall be made and these shall be covered with GI chequered sheets 8 mm thick. GI support angles/trays shall be provided for cable laying.

7.9.14 The indicative layout of the substation, fencing etc. along with area has been given in the Tender drawings. Contractor shall submit the final layout design for Engineer's approval after taking into consideration the sizes of various equipment etc.

7.9.15 Tower Wagon Shed shall be constructed with inspection pit and maintenance facilities. Necessary lights in inspection pit and in the shed area, exhaust fans, power points and power sockets for welding/heavy work shall be provided. The plinth area of the shed shall not be less than as indicated in the drawing. The cables wherever cross the floor shall be through HDPE pipes not less than 75 mm dia (PN-4). The pit lights shall be provided with bulk head light fixtures on each side of the pit (wall) to cover entire length. 6 Amp and 16 Amp sockets with switches outdoor type shall be provided at interval of 5 meters. 32 Amp three phase sockets with 4 pole MCB shall be provided at both the ends of the pit.

7.10 NUMBERING OF EQUIPMENT

The number plates of equipment in TSS and switching stations shall be non-retro reflective type and meet the guidelines of ACTM Vol.II. The Equipment Numbering Scheme shall be approved by the Engineer (with the consent of Employer) and will be updated to make it compatible with adjacent section.

7.11 220kV/132 kV, 55KV AND 25KV BAYS, LAYOUTS AND BUS BAR ARRANGEMENT

The 220/132 kV, 55kV and 25kV bays shall be arranged as per the general arrangement layouts of TSS, SSP and SP. The bus bar in 220/132 kV bays may be flexible type whereas on 55kV and 25kV bays shall be suitably sized rigid aluminum bus bar type for higher short-circuit withstands capacity, reliability and Maintenance friendliness suitably rated for Thermodynamic stress due to short circuit in conformance to relevant IEC/ EN standards.

(End of Chapter 7)

CHAPTER 8 - DESIGN CRITERIA AND PERFORMANCE SPECIFICATIONS FOR FLEXIBLE OVERHEAD CONTACT SYSTEM(OHE) AND RIGID OVERHEAD CONDUCTOR SYSTEM

8.1 GENERAL REQUIREMENTS

8.1.1 General

(1) This specifications covers complete design, supply, construction, installation, testing and commissioning of High Rise Overhead Equipment (OHE) & ROCS in twin Tunnel for main lines, yards, viaduct and connecting tracks to Indian Railways and DFCCIL to provide traction power to trains having trailing loads as per "Train operation plan" in clause 5.2.

(2) The OHE design shall conform to technical, operational, economical, maintenance and application duty requirements and shall be suitable for local environmental conditions. The OHE system shall be designed as per application duty requirement with sufficient capacity with redundancy to cater to foreseeable load /current demands, without any degradation of any of its components. The OHE design shall be coordinated with the locomotive dynamic performance characteristics to ensure that the current collection quality is maintained within acceptable limits. Overhead contact line shall also be designed, constructed and maintained in such a way that due regard is given to safety of the public, durability, robustness, maintainability and environmental considerations as per EN 50119.

(3) The principal components of the scope of work shall include but not be limited to the following:

(a) Complete 25kV Auto Transformer (AT) fed, flexible polygonal sagged simple auto-tensioned Overhead Equipment (OHE) including parallel reinforcing conductors along the track, foundations, steel structures,2x25kV feeders and cross track cable terminations and associated insulators and hardware, jumpers;

(b) (**+**)25kV and (**-**)25kV cable/Overhead feeders and flexible cable feeder connections from track-side bus to the tracks;

(c) Traction Return current Path through rail, negative feeders, AEW and BEC (if required).

(d) Track Bonding and Earthing;

(e) Survey and execution of Safety Earthing of other Service Buildings, adjacent steel structures alongside the track including those of Indian Railways and DFCCIL alignment running alongside as required;

(f) Provision of Isolators

(g) 25 kV OHE system for yard lines at the stations and for the connecting chords of IR.

(4) The OHE shall also accommodate the requirements of systems associated with the locomotives & rail wagons, such as clearance envelopes, other schedule of dimensions, signalling and telecommunication systems.

(5) The OHE shall be designed for two pantograph operations at full design speed,

(6) It would be essential to have computer software-based OHE designs to the extent possible so that repeated detailed calculations are reproducible easily for different locations and loading conditions of overhead equipment for ease of quick & techno-economical designs through computer software in compliance with EN: 50119.

(7) For ease of construction as well as maintenance and smooth inventory control, designs of different fittings, fixtures, insulators, droppers, clips, clams etc. should be of maximum interchangeable types.

8.2 FACTORS GOVERNING DESIGN OF OHE

8.2.1 Design Speed

The overhead equipment shall be of simple sagged polygonal type design (ROCS in Tunnels) auto- tensioned in conformance to EN50119 and shall be designed for a maximum permissible speed of 160 kmph.

8.2.2 Earth work

The actual details of the earth work including formation width, embankment, curves, cant and other track parameters shall be obtained from Civil contractors for OHE system design and continuously coordinated for access with civil contractors. The indicative values are, however, given in General Specifications, Maximum Moving Dimensions (MMD) and Structure Gauges as per the details given in the Indian Railways Schedule of Dimensions, 1676 mm Gauge (BG) – 2022 (with latest advance corrections slips).

8.2.3 OHE structures on bridges

(1) Locations and details of Major bridges/RFOs may be referred to in the alignment drawings and typical arrangement drawings given in Part-2, Section VII Volume 3 : Tender Drawings of these documents. Structures to support traction overhead equipment may be required to be provided on the bridge piers. Exact span of Bridges shall be taken from the various Civil contractors undertaking the civil works in the section.

(2) On long bridges and long viaduct, OHE anchors and supports may also be required on bridge/structures itself. On through girder bridges, the overhead conductors and pantograph swept path shall have to be provided with adequate electrical and mechanical clearances. These may need special designs to meet the additional clearances and support requirement.

(3) The design and erection of OHE structures on these bridges and earthing &bonding of all structures shall be carried out in close co-ordination with the Civil contractor.

(4) For OHE masts to be erected on bridges and viaducts, the Civil Contractors working in various parts of the Pirthla – Harsana Kalan section shall provide holes for fixing Masts with base plates. The contractor shall interface with Civil Contractor so that masts with base plate are ordered and fabricated at the supplier's works and duly galvanized after welding and drilling holes in the base plate.

8.2.4 Minimum clearances to be adopted

Table 8.2.4 -: Minimum E & M Clearance (mm)

Item	Normal
25kV Live metal to Earth	
- Static	250
- Dynamic (passing)	200
25 kV Live metal to vehicles	
- Static	290
- Dynamic	220
Clearances for different phase (50 kV)	
- Static	540
- Dynamic (passing)	300
Between conductors of different Electrical Sections	
Gap at Insulated Overlap	500
Gap at Un-insulated Overlap	200

(1) Mechanical clearance from the pantograph to any fixed structure, excluding the registration assembly, steady arm or registration pipe of the cantilever, shall be not less than 200 mm, except at locations where a locomotive is expected to halt as a matter of normal operation. Clearance to steady arms and registration assemblies or tubes used for registration purpose shall not be less than 35 mm under worst case operating conditions including dynamic displacement of the vehicle, the pantograph as well as track and maintenance tolerances.

(2) Contact wire gradients and change in the gradient shall be in line with EN 50119.

(3) Under Indian climatic conditions, particularly during peak summer months, where the temperature goes as high as 50˚C, the thermal expansion of aluminum and copper conductors are different. This has been particularly posing problems while passing OHE traction wires & return feeder wires under heavy over line structures and in areas with thick vegetation growths. Therefore, Contractor shall conduct a study and provide clearances as needed. The clearances as indicated are minimum and the clearance between live and dead / earthed portion may be increased where ever possible particularly the stranded conductors, to avoid tripping due to birds coming in proximity and bridging the gap and getting electrocuted, and increasing the reliability of the OHE system generally conforming to General arrangement Drawings of RDSO or Other Standards whichever gives more reliability.

(4) At over-head bridges, clearances from top of rail to the underside of bridges shall be scrutinized to ensure that adequate vertical clearance is provided: that is linked to the height of the vehicle, the electrical (air) clearance, the height of the catenary, catenary tolerance, track tolerance, bridge structure tolerance (for a new overhead bridge). Criteria for determining minimum vertical clearance are given in the ACTM. To achieve sufficient clearance at over-head bridges, grading of the catenary system height down while maintaining a level contact wire, is an option.

8.2.5 **Aerial Earth Wire (AEW)** is generally kept at higher level to serve the purpose of lightning protection, however the AEW height/ level at the lowest point shall not fall belowthe contact wire level at the maximum temperature. The Contractor shall arrange the OHE arrangement as per drawing annexed in Part-2, Section VII Volume 3 : Tender Drawings.

8.2.6 The following design features of OHE as on Indian Railways may be adopted to, for similarity with IR system:

(1) Normal Encumbrance: (Axial Distance between Contact wire and the Catenary wire in a vertical plane at the structure): 1.4m.

(2) Standard spans

OHE spans shall be in multiples of 4.5 m from a minimum of 27 m to a maximum of 54 m span length, the designer shall consider the effects of the following but not limited to:-

(a) OCS (Overhead Conductor System) conductor blow off,

(b) Contact wire height,

(c) Contact wire stagger,

(d) Contact wire mid-span offset,

(e) Contact wire stagger effect on tangent track,

(f) Contact wire deviation due to track movement,

(g) Mast deflection due to imposed loading,

(h) Vehicle dynamics,

(i) Width and sway of the pantograph,

(j) Track tolerances, and

(k) OCS erection tolerances,

(3) Stagger of Contact Wire:

(a) On straight : 200 mm

(b) On curved track : 300 mm

(4) The maximum distance between anti-creep to the Anchor structure: 750m as on Indian Railways.

(5) Overhead Equipment (OHE) Mast /Structures for the mainline tracks shall be mechanically and electrically independent except where specifically approved by the Engineers. Design for steel structures shall comply with IS: 800 which is the Indian Standard Code of Practice for use of Structural Steel. Design method as adopted in Indian Railways design manual for electric traction may be followed for guidance. Concrete structures shall not be used.

8.2.7 The OHE System shall be suitably designed to integrate with the OHE of adjoining sections of DFC and IR for smooth sailing of pantograph mechanically and electrically, giving due consideration to the prevailing weather conditions.

8.3 SECTIONING OF OVERHEAD EQUIPMENT

8.3.1 Introduction

HORC's Stations are generally 10 — 17 km apart with crossing stations for giving precedence to trains. The OHE is divided into electrical sections for maintenance and operating purposes to cater to over-head equipment failures, isolation required for emergency work, apart from isolation for routine maintenance. The switching 'ON' & 'OFF' of OHE for main line sections and yards, shall generally be through remote control from the Operation Control Centre, however, it shall also be operable manually for local Power Blocks. On mainline sections, electrical sectioning is normally provided by insulated overlaps. The section is divided into smaller zones by way of switching stations or isolation of different sections, whenever required. A continuity of the electrical sectionsis maintained as per approved scheme through circuit breakers, interrupters (on load switches) and off load disconnects switches which may be motorized or manually operated. The sectioning shall be minimum, to provide for flexibility of operation. The indicative sectioning layout for Prithla to New Harsana Kalan section is shown in the Part-2, Section VII Volume 3 : Tender Drawings. The Entire section between Prithla to Harsana Kalan shall be sectionalized through TSS, SSP, SP and Sectioning Switches (motorized Isolators) at Stations for main line. Mid-section isolations are not planned; however, isolations shall be provided as essentially needed for minimizing the affected sections in case of faults, without impacting receipt and dispatch at the station through healthy lines. The OHE between the Stations may be under Power block in case of Maintenance or failure, the station Loops shall be planned to be isolated through the Motorized Isolators

8.3.2 The OHE shall be sectionalized through remote controlled switching and auto fault localisation, so as to maximize the availability of operational track in the event of:

(1) An overhead equipment failure.

(2) OHE failure due to external cause

(3) An isolation required for routine maintenance

(4) Isolation required for emergency work.

8.3.3 Sub-sectioning Post (SSP)

The SSP sectioning shall be arranged such that movement to various lines and yard line is maintained, by isolating the smallest portion of tracks for maintenance or breakdowns. Portions of station yard can be made dead whilst the rest of the mainline and yard is energized and vice versa.

8.3.4 Sectioning Post (SP) and Traction Substation (TSS)

At SP and TSS locations, there shall be sectionalisation to allow one sub-sector/section to be isolated from the next section. The section isolation shall be arranged such that safe isolation can be made for maintenance purposes, whilst the adjacent section remains alive. Autotransformers are connected on either side of the Neutral section serving as the last AT of the respective feed section.

8.3.5 Isolation of Faulty Auto transformers

To isolate faulty auto-transformers, each auto-transformer will be automatically disconnected through Circuit Breakers across the Transformer as per IE rule and approved protection scheme. All the Circuit breakers provided for Auto Transformers at TSS/SSP/SP shall be with double pole isolators to facilitate its maintenance. It shall be possible to isolate the faulty Auto Transformer as well the section fed remotely through SCADA.

8.3.6 Position of Sectioning Switches (motorized isolators)

The Sectioning switches (motorized isolators) as required for facilitating the adequate sectioning shall be considered before and after the stations as appropriately required. Sectioning Switches shall be suitably configured to facilitate easy isolation through SCADA in case of maintenance and occurrence of OHE fault. Single Sidings/ loop lines shall be isolated through Motorised Isolators.

8.4 OHE CONDUCTORS

(1) Minimum Sizes of Conductors

The contractor shall design the Traction system conductors sized to meet the requirements for freight traffic to be hauled as per HORC's "train operation plan" and as given in clause 5.2.2 of these specifications. The Minimum sizes of conductors are mentioned in the Table No. 8.4-1 below:

Table: No 8.4.1: OHE Conductors

Conductor	Minimum Nominal Size (mm^2)	Material	Remarks
Catenary	120	Copper Alloy	Material having temperature withstand capacity minimum 100^0C as per EN50119 and conforming to DIN 48201 (Part II) or RDSO Specification No. TI/SPC/OHE/CAT/(Cu-Cd)/0971 (latest).
Contact wire	150	Copper Alloy	Material having temperature withstand capacity minimum 100^0C as per EN50119 and conforming to EN50149 or RDSO Specification No. TI/SPC/OHE/CW/0971 (latest).
25 kV Feeder Wire	288	AAAC	Material having temperature withstand capacity minimum 80^0C as per EN 50119 shall be used.
Aerial Earth Conductor	92	ACSR	Material having temperature withstand capacity minimum 80^0C as per EN 50119 shall be used.
Buried Earth Conductor	As required	Galvanised Steel	Material having temperature withstand capacity minimum 80^0C shall be used.

(2) Catenary (Messenger) Wire

The catenary wire shall be minimum 120 mm² copper alloys conforming to DIN 48201 –Part 1 and Part 2, EN 50119, DIN48200, DIN 48203 or any other equivalent international standard capable of withstanding minimum temperature of 100^0 C.

(3) Contact Wire

(a) The contact wire of minimum 150 mm^2 shall be manufactured out of continuous cast rods by any process conforming to EN 50149/ or RDSO guidelines and withstand a minimum temperature of 100^0 C continuously without affecting the mechanical properties as per EN 50119. The Contact

Wire shall be BC type (Round Bottom).

(b) The contact wire shall be continuous, i.e. splicing or jointing of the conductors is not permitted between terminations or between cut-in insulators. Splices are primarily used during maintenance and shall not be used in the contact wire and / or catenary wire by way of installation or repair unless approved by the Engineer.

(4) Normal height of Contact Wire shall be 7570 mm from rail level. The minimum Contact wire height from rail level shall be 7220 mm or as per IR SSOD-2022 as amended (latest) or the recent guidelines issued by Indian Railways.

(5) Aerial Earth Wire (AEW)

Aerial Earth wire (AEW) of adequate size and rating shall be provided aerially adjacent parallel to or above the OHE conductors, attached to OHE supports collectively to ground or to the grounded running rails to protect people and installations in case of electrical faults. AEW provides a continuous return path to fault/leakage current through insulator if any or earth fault between live OHE and the earthed masts and connects to BEC (if required). AEW shall be located suitably to efficiently protect against the lightning stroke. The design shall determine the required spacing of interconnections to the rails which must be coordinated with requirements of compatibility with the signaling system. AEW shall be of Aluminum Conductor Steel Reinforced (ACSR) material of appropriate size with fixed termination and erected on mast parallel to the OHE system as per the results of simulation study conducted by the contractor.

(6) Buried Earth Conductor

Buried Earth Conductors (if required) of appropriate size, as validated through calculations, taking in to account the possible corrosion over 25 years life, shall be laid on the alignment and connected to AEW and running rails of the track at regular intervals.This shall be confirmed through the traction power load flow simulation results and the touch / step volts analysis to keep the rail Touch and Step potentials withinacceptable limits, both for normal and OHE/feeder fault conditions, as per EN 50122-1 generally as per scheme given in Part 2, Section VII-3.

(7) Negative Feeder Wire (NFW)

In 2x25 KV traction systems, OHE line will be equipped with negative feeder wires of AAAC, supplying power to auto-transformers. The NFW will be strung from the super masts attached as extensions on the OHE masts or Extended OHE mast. The NFW shall normally be placed on the track side of the mast. The suspension insulators of NFW shall also follow the norms as given for OHE. The clearance between feeders and the catenary system should remain adequate under adverse wind & highest ambient temperature conditions including gap as essential to minimise the electrocution of birds/ crows as per schematic attached in Section VII-3.

(8) The proposed sizes of all types of conductors, including jumpers, droppers etc. shall meet the application duty requirement and will be validated through detailed design calculations and the results of simulation studies. The Conductor of higher sizes shall be provided, if needed as per the results of simulation study conducted by the contractor. The Contractor may where practical, optimize on the number of parallel feeders and shall install them where necessary.

(9) The multi train simulations shall be used to prove that the wire temperatures are within design limits as stipulated in EN-50119, under all operational configurations. The Contractor shall identify any operational limits in the design report.

(10) Particular attention shall be paid to design and construction of OHE at critical locations of cross - overs and turn- outs so as to minimize/eliminate the possibility of panto-entanglement with the contact wire in conformance to EN:50119.

(11) The tension length of OHE is governed by the limitations imposed by the expansion and contraction due to temperature changes and the system design chosen to accommodate this change while providing suitable tensioning of the system. While defining the maximum tension length, particular attention must be paid to the along-track movement and stagger change. Tensions to be adopted in different overhead conductors shall be specified by the designer along with the system of anchoring. The tension length and contact wire pre-sag and gradient shall be decided, supported by the requisite calculations, for smooth and spark-free current collection by the loco pantographs.

8.5 SPLICES, CLAMPS AND OTHER TENSION FITTINGS FOR THE CONDUCTORS

8.5.1 The performance of fittings designed to terminate or splice stranded or individual wires is critical to the efficient operation and maintenance of the OHE.

8.5.2 The OHE fittings shall be tested in tension, in a special Jig to simulate the load characteristics experienced in service. The contractor shall demonstrate its suitability by FEM Analysis.

8.5.3 The tensile failing load of the fitting shall exceed the failing load of the wire or stranded wire with which it is to be assembled and used.

8.5.4 When the fitting is tested and assembled to the allocated wire or stranded wire the assembly shall achieve 85% or greater than the specified tensile failing load of the wireor stranded wire.

8.5.5 Applicable factors of safety for design shall be as per European standards EN 50119.

8.5.6 Splices are primarily for use during maintenance and shall not be used in the contact and/or catenary wires by way of installation or repair. If need arises due to any exceptional reason, same shall be done with specific approval of Engineer.

8.5.7 Unless otherwise specified in this bid document, all bolts, studs, nuts, washers and pins used for the current carrying conductors shall be of stainless steel or high tensile copper alloy. However, for all other applications, galvanized steel may be used with particular reference to the prevention of corrosion.

8.5.8 All fittings, components and materials to be used on the Project shall be subject to prototype tests as per provisions of Employer's Requirements.

8.6 ELECTRICAL CONNECTIONS

8.6.1 The connections shall be robust, to withstand both static and dynamic loads, along track movement, wind pressure (Temperature variation in conductors and operational vibrations).

8.6.2 Design of fittings and connections shall ensure no localized temperature rise at the connection to prevent any damage or deformation or adversely affect the mechanical capacity of the conductors or their electrical performance.

8.6.3 Where dissimilar connecting materials are used appropriate measures shall be employed to mitigate the risk of bimetallic corrosion.

8.6.4 Protective bimetallic tapes and shells shall be used at clamps and terminals used with aluminium and copper conductors and cables.

8.6.5 Nominal working pressure shall be kept up to compensate the permanent temperature deformations and generation of local overheats.

8.6.6 The tapes and shells shall envelope 10mm outside of clamps on both sides.

8.7 FLEXIBLE JUMPERS AND FEEDER CONNECTIONS

Flexible Jumper Wire shall be fabricated from soft annealed, high conductivity copper with stranded conductors. The size of the jumpers shall be decided based on simulation study and temperature rise shall be within limits in extended feed conditions. The jumpers shall conform to DIN 43138. The capacity of jumpers, cross feeder wires, drop jumpers from cross feeders, along feeder wires, isolator jumpers etc shall match the capacity of OHE (catenary and contact wires) and their size shall be uniform in the entire section. The size and no. of parallel runs of cross feeders, along feeders etc shall remain the same for OHE & NFW.

8.8 FLEXIBLE DROPPERS

Flexible droppers shall be of minimum nominal cross section of 10 sqmm and shall conform to DIN 43138. Each current carrying dropper shall be of bronze strands and two dropper clamps, one of which is connected to the contact wire, and the other to the catenary wire. The maximum resistance at the joint between the bronze dropper wire and the clamp, and at the contactpoint between the clamp and the catenary and contact wire, shall be less than the resistance of the conductor of the same length. The maximum temperature rise at the joint and at the contact surface shall not be higher than that of the conductor. The tensilebreaking load of the complete joint shall not be less than 90% of the failure tension of the dropper wire. The factor of safety for flexible droppers shall be as per EN 50119.

8.9 BURIED EARTH CONDUCTORS (BEC, if required) Connections

8.9.1 The Contractor shall connect AEW, BEC (if required) and running rails of the tracks at regular intervals to keep the rail touch and step potentials under acceptable limits both fornormal and fault conditions including Auto Transformer Failure Condition. It shall be the responsibility of the Contractor to determine the sizes of the AEW and BEC (if required), distances of their connection to rails /earth so as to ensure a safe system both under normal and fault conditions as per EN-50122-1. For the calculation purpose time duration for clearance of fault may be considered as 300ms.

8.9.2 BEC (if required) conductor shall be connected to Rail, Masts and earthing stations by the contractor as per the indicative Scheme given in Section VII-3.

8.10 CANTILEVER ASSEMBLIES

8.10.1 The cantilever assembly shall conform to EN 50119. The contractor may adopt the cantilever assembly conforming to RDSO / IR specifications/ maintenance friendly with modular design proven in any international project, if it meets the functional requirements of the project. In case the contractor offers any new Cantilever Assembly design, the same shall meet the proven design criteria as per clause 4.4.2 of chapter 4 of this specification. Cantilever made of fiber shall not be used.

8.10.2 The Contractor shall ensure that the range of cantilever frame components is suitable for the loadings and applications shown in the Drawings and these Specifications.

8.10.3 The proposed cantilever frames will sustain the normal and worst case loading conditions with a factor of safety not less than 2.5.

8.10.4 The cantilevers shall be designed such that they can be pre-assembled off site fordelivery to site. FEA (Finite Element Analysis) of the Cantilever Assemblies shall be carried out and got approved from the Engineer.

8.10.5 The contact wire registration profile shall accommodate the permissible extremes of uplifted and swayed pantograph movement in addition to the effects of track tolerances and include allowance for mechanical and electrical clearances and to be in accordance with the stipulations of IR SOD-2022 (with latest correction slips).

8.10.6 Fittings connected to the in-run contact wire shall utilize the wire groove and shall be shaped to maximize clearances to the pantograph head when uplifted by the extreme operating running conditions and shall take account of pantograph and contact wire wear and to be in accordance with the EN/ IEC standards.

8.10.7 Assemblies shall allow for the adjustment of contact wire stagger and the equivalent catenary adjustment by 75mm either side of the designed position without changing components.

8.11 OHE ASSEMBLIES, FITTINGS, HARDWARE

8.11.1 The fittings, tubes and hardware shall confirm to RDSO/CORE (Indian Railways) specifications for these items subject to their suitability for the ratings and situation applicable for use on the HORC corridor where the Contractor offers components of different ratings, design or configuration conforming to other National and International specifications of proven design, details of the specifications and performance elsewhere shall be furnished for approval as per provisions in clause 4.4.2of chapter 4 of these specifications.

8.11.2 All threaded fasteners, washers, headed pins and locking pins etc. shall generally conform to appropriate Indian Standards Specifications. The Contractor shall prepare and submit for the Engineer's approval a list of all applicable specifications for threaded fasteners, washers, headed pins and locking pins etc.

8.12 AUTO TENSIONING DEVICES

The tension in the contact and catenary conductors of the flexible overhead equipment shall be regulated at all temperatures by auto-tensioning devices of proven design at both ends. The Auto Tensioning Device shall conform to EN 50119. The contractor may adopt anchoring of catenary and contact wire on the same mast through regulating equipment as per application duty requirement. The breaking strength of the stainless steel wire/rope shall not be less than 2.5 times the maximum computed working load. The use of gas ATD shall be restricted to viaducts and tunnels.

8.13 25 KV CABLES

8.13.1 25 kV,ac, cables shall be XLPE Insulated, armoured, single core copperconductor Cables conforming EN/IEC 60502-2, IS:7098-3 meeting the application duty requirement and tested to EN/IEC 60840 as per the 52kV (for 25 kV) class Insulation. The insulation thickness shall meet the Testing requirement of EN60840. The outer sheath of the cables shall be protected against ultra violet radiation.The Cables laid in the ground shall be provided with Radial and longitudinal water ingress protection in terms of relevant standards and shall be tested for water penetration test. The Cable shall conform to the laying method requirement and de-rated suitably as per the stringent condition witnessed by the cable. The Conductor shall be provided with semiconducting screen tape and triple extruded layers of semiconducting compound, XLPE and semiconducting compound with Longitudinal water absorption/protection layer /insulation metal shield, Round wire armoured, Binder tape and Over sheath at least ST-2 class as per application duty requirement.

8.13.2 In order to protect the insulated cables and associated equipment from atmospheric voltage surges, TSS and traction switching station feeder cable connections to the OHE shall be provided with gap less lightning (surge) arrestors with leakage current detector and surge counters.

8.13.3 Cables shall be placed in protective metallic Pipe/ conduit to protect the cable vertically up to a height of 1.8m above the ground to protect against mechanical damages/ vandalism. The Bottom end of metallic conduit shall be embedded in the concrete/ the plinth level of structure and top end shall be sealed to avoid the trapping of the Rain water.

8.13.4 All the Cables shall use the Heat shrinkable Termination kits as per the applicable standards to protect against the ingress of water and terminations.

8.14 STRUCTURE/UPRIGHTS AND THEIR FOUNDATIONS

8.14.1 Overhead equipment structures for the main line tracks shall be mechanically and electrically independent except where specifically approved by the Engineer. In station yards, having 3 or more tracks, generally, portals shall be erected as per yard plan. Portals with larger number of tracks as per yard plan may also be required in station yards. For this purpose, adequate track centers shall be provided by the Contractor . Design for steel structures shall comply with IS 800 - Indian Standard Code of Practice for use of structural steel in General Building Construction. Pre-stressed concrete structures shall not be adopted.

8.14.2 The structures / uprights shall generally be embedded in PCC / Reinforced concrete. The Concrete for the foundations shall conform to EN50119, BS 8004. In view of the faster installation requirements mechanically augured / excavated, Cast in Situ Cylindrical foundations mechanically augured not less than M-20 grade concrete of suitable size, may be proposed as compared to rectangular foundation design generally used in Indian Railways. For RCC foundations, the reinforcement shall be connected to the Mast for ensuring it as an Earthed structure as per EN 50122-1. Precast prefabricated foundation shall not be used. The formation of track is normally 5 m above the ground level in the open sections.

8.14.3 The Contractor shall carry out geotechnical survey. This data shall form the basis for design for foundation as per EN50119. The Contractor shall undertake sufficient Geo-Technical investigation to demonstrate that the foundation designs are adequate. The consideration shall be given while design of Foundation to all the factors including the electrical resistance of the foundation to earth as per EN50119 and foundation design calculations shall be furnished.

8.14.4 Location and Setting distance of Structures

(1) Location of structures shall be selected after ensuring that there are no infringements and they do not obstruct roadways, pathways, run of cables, drains, or signals etc.

(2) Setting distance of fixed structures shall not be less than that specified in IRSOD for HORC. This shall be, however, subject to review by the Engineer. The location of traction masts shall be such that visibility of signals is not obstructed and shall be as indicated in ACTM. The OHE supporting masts/portals/ drop arms etc. shall be coordinated with signals locations to ensure clear signal visibility.

(a) Extra clearance on Curves

The minimum setting of structures on curves shall be increased by the figures for curve allowance being taken from Schedule of Dimensions for HORC.

(b) Structures with Counter Weights

In case of structures carrying counter-weight assemblies, the term "setting" shall refer to the minimum distance of the mast including the counter-weight from the track center. The minimum and maximum travel of counter weight shall be marked on the mast along with reference temperature.

(3) To ensure provision of safe & efficient current collection under adverse conditions, the deflection of masts on top of the OHE structure shall not exceed 8 cm and the mast shall be erected such that it becomes vertical on application of permanent loads. The mast shall not further deflect more than 8 cm under the wind load. Torsional deflection under permanent loads shall not exceed 0.1 radian.

(4) The value of setting distance of masts/structures shall be painted on each mast/structures. The figures shall be 25mm in size in white on a red background. In addition, the track level, contact wire height and stagger shall also be marked on the mast/structure by a horizontal red painted stroke.

(5) Numbering of Structures Carrying Overhead Equipment

Structures shall be numbered in accordance with the standard numbering given in the finalized overhead equipment layout plans. Number plates at eye level from a locomotive driving cab (approx. 3m above rail level) shall be provided on each mast or structure. Non retro reflective and retro reflective type number plate shall be used as per RDSO guideline. Details to be submitted for review by Engineer.

(6) Signage for OHE

Signage shall be provided on steel structures/ standalone boards. All signage shall be retro reflected type in OHE. The locations of signs shall be as under but not limited to:

(a) Critical locations like before the stop signals and before the permanent speed restrictions.

(b) Up and Down Gradients

(c) All other warning boards as per ACTM like DJ (Locomotive circuit breaker) open, DJ close, 500 m board, 250 m board, danger board, brake testing board, overhead crossing board etc.

(d) Sigma strip shall be provided in fog prone area on two masts prior to all signal locations for easy identification during foggy weather

(e) Other unusual locations

(f) Guidelines for numbering contained in clause 3.31 of ACTM Vol. II shall be followed. The proposed location shall be approved by the Engineer.

8.14.5 Construction design shall include the Construction Employment Schedules for structures and the foundations for different situations of loading expected to be encountered on the route.

8.14.6 Field work shall only be commenced when the Contractor has received a letter of no objection to the proposed mast and foundation designs and construction methodology from the Engineer.

8.15 TOLERANCE IN ERECTION:

1.	In Span Lengths shall not vary more than	+/- 200 mm
2.	Cumulative error in all spans in one km shall not exceed	+/- 1000 mm
3.	Height of Contact Wire	+ 20 mm
4.	Dropper Location	+/- 100 mm

8.16 OUTDOOR STEEL PARTS

The zinc coating for steel structures and parts shall be as per RDSO Specification no. ETI/OHE/13 (4/84) (latest) and all outdoor steel parts used in all applications shall be galvanized.

The Zinc coating specified in the equipment specification, if any, will also be considered and most stringent Zinc coating out of the two will be applicable as approved by the Engineer.

The polluted areas shall be identified as a result of pollution mapping by the contractor and approved by the Engineer, where the zinc coating shall be 1000 gm/ m^2. In case of need to use nonstandard SPS at special locations to be fixed to the steel structure, these shall be with clamps to avoid drilling of galvanized mast sections.

8.17 ANTI-CLIMBING GUARDS, SAFETY SCREENS, WARNING /DANGER SIGNS etc.

8.17.1 Anti-climbing guards shall be provided for all structures supporting Auxiliary Transformers.

8.17.2 Screens and anti-climbing guards shall be provided on OHE supports at locations where any person can either touch or gain access to live overhead conductors, such as the signal posts located near live conductors.

8.17.3 Where deemed necessary the equipment and critical points shall be clearly identified with warning and danger signs positioned at appropriate intervals, distance and heights.

8.17.4 All safety critical items shall be secured by bolts, clamps, etc., and shall be fitted with vibration and shock proof, self-locking washers or secured with split pins behind the nuts.

8.17.5 The device shall be clamped to the structure that it protects, and no drilling of the structure shall be acceptable.

8.17.6 The anti-climbing guards shall be positioned to allow unimpeded access to maintenance staff during the normal course of their duties.

8.17.7 All steel items shall be galvanized.

8.18 INSULATORS AND SECTION INSULATORS

8.18.1 Insulators

(1) Selection of insulators shall be based on the tropical environment. Composite polymer insulators of longer creep-age path shall be used at locations subjected to level of pollution in the zone and also at Level Crossing Gates.

(a) For this purpose, the Contractor shall undertake a survey, tests and a pollution mapping study to categorize levels of pollution level along the route in order to provide insulators suitable for the level of pollution in the zones, structure protection and other protective measures for the OHE. The governing specifications to determine the level of pollution for Insulation and corrosion resistance shall be EN 50119.

(b) The insulators selected shall be Maintenance free with higher Creepage distance and long life and should not require any cleaning.

(c) All insulators shall be, anti-tracking, solidly bonded with weatherproof seals to appropriate end caps.

(d) Porcelain insulators as per RDSO Specifications No. TI/SPC/ (OHE)/ INS/0071 shall be provided at all locations except at polluted locations and LC Gates where insulators as per RDSO Specifications No. TI/SPC/(OHE)/ INSCOM/1071 shall be used. The locations where polluted zone type of insulators is to be installed shall be proposed after survey and shall be installed with the approval of the Engineer.

(e) For new cantilever assemblies, approved under cross acceptance criteria as per clause 8.10.1, the composite type insulator for cantilever can be proposed for the approval of Engineer, if the same is part of the cantilever assemblies approved under cross acceptance criteria.

8.18.2 Section Insulators

(1) The Section Insulator (SI) is a device installed in the contact — catenary wires system for electrical separation of two elementary electrical fields while allowing for the passage of a vehicle pantograph, such as in a cross over between two adjacent tracks. The SI shall consist of an insulator located in the catenary wire above an insulator located in the contact wire immediately below it. The contact wire insulator is designed to allow passage of the loco-pantograph across it. To ensure continuous current collection during the pantograph passage, the most commonly used SI contains a side runner located on each side of the unit: the siderunner overlap.

(2) Section insulators shall not be installed in main line equipment. These shall operate at the required speeds in either direction.

(3) The section insulator shall be compatible with the mechanical and electrical characteristics of the contact wire, and the system power and electrical clearance requirements for the overhead contact system.

(4) Type test validation shall be required for the section insulators proposed for the contract.

(5) The section insulator offered by the Contractor shall be light weight of a Latest design with proven performance in mechanical, electrical and environmental conditions as specified in these specifications. The section insulators shall be

designed to withstand arcing caused by the passing of pantographs with no reduction in mechanical and electrical integrity even if a pantograph runs into an isolated section for a period of three (3) seconds.

(6) The governing specifications for the electrical and mechanical testing requirements for insulators shall be according to EN50151, IEC 61109 and EN50119.

8.19 DESIGN OF NEUTRAL SECTIONS

(1) Neutral Sections (NS)/ Phase breaks are insulating units installed in the OHE System that achieve electrical phase separation while allowing physical continuity of the contact wire for the passage of a pantograph. The Phase Break is used to separate different over-head electrical phase sections.

(2) NS are located away from passenger stations, signals or any location where a train may stop, as the train must coast through the phase gap at a reasonable speed of optimum operation.

(3) The neutral sections shall be short PTFE type conforming to RDSO design.

(4) The location of neutral section for the TSS, SP is to be judiciously selected such that trains are able to coast through the TSS and SP with power off with least risk of stalling. Neutral section shall be provided in a tension length not exceeding 600 metre and one end of tension length shall be FTA.

(5) Accordingly, their location shall be subject matter for interface coordination with the civil works. The track alignment Drawings and station layouts may be carefully examined and location of Neutral sections proposed accordingly and coordinated with Civil contractor. The neutral sections on connection to IR should be as close to IR as feasible.

8.20 EARTHING AND BONDING SYSTEMS FOR OHE and STEEL STRUCTURES

8.20.1 The contractor shall develop Earthing and Bonding Management Plan with measures to connect all the structures/ buildings in proximity of Track system and provide low potential earthed rail system including the provision of the Earthing stations, Earth mats, AEW, BEC (if required). The Contractor shall demonstrate through calculations the rail potential rise within the prescribed limits during stringent fault conditions as specified in EN 50122-1.

8.20.2 The Earthing, Bonding and Safety system design shall provide the means to carry e lectric currents into the earth under normal and fault conditions, without exceeding any operating and equipment limits, without thermal degradation or mechanical breakdown and without adversely affecting continuity of service. Earthing & bonding should create a conductive path that shall achieve potential equalization of the grounded elements of the railway system.

8.20.3 Adequate Bonding shall be designed and installed throughout the entire electrified route to provide return circuits for the normal traction power currents as well as fault current as may be witnessed during the broken rail or Rail Maintenance without raising the touch potential and compromise to the safety of General public or Rail personnel in proximity/ touch. The contractor shall demonstrate the potential rise in all possible OHE/Power fault case scenarios remains lower than the permissible limit at any point as per relevant standards including step and touch potential while on going discontinuity in Rails unnoticed like hair cracks etc. and discontinuity of AEW due to failure/theft if any in two independent systems.

8.20.4 Work shall be taken up according to the approved Earthing & Bonding Plan prepared by the contractor and shall include as under:

(1) Survey and tests for soil resistivity as required for earthing requirement,

(2) Provision of earthing stations and earth mats to limit the step and touch potential,

(3) Connection with running rails, Masts, AEW and BEC (if required),

(4) Connection to Buried rail at TSS, SSP, SP,

(5) Separate and Distinct Earth Station for Lightning Arrestor,

(6) Passing of the return current through mass of earth,

(7) Provisions of return current cables,

(8) Grounding interconnection,

(9) Grounding (Earthing), Bonding and Safety provisions of all items, equipment & sites which include OHE structures, auxiliary transformers, all switchgear, buses, cables, feeders, equipment enclosures, associated buildings and other fully or partially conducting items likely to come in contact with rail systems personnel, rail users and general public.

(10) The OHE mast/portal shall be grounded through interconnections of the mast to the AEW so that the ground resistance of the interconnected masts is kept low. RCC and anchor bolt foundations, where the concrete is in good contact with the adjacent soil, are recognized as being good earth electrodes. But where the ground resistance of individual masts exceeds 25 ohms, individual ground rods or other grounding solutions shall be applied by the contractor.

(11) Contractor shall connect Earth electrodes, mast/portal structures, and running rails of both the tracks at regular intervals, as per result of simulation study, but such connection interval shall not exceed 400 metres. Contractor shall keep the rail touch and step potentials under acceptable limits both for normal and fault conditions.

(12) Ground connections to disconnect switches and ground leads from surge arrestors, shall have a maximum ground resistance of 5 ohms. Ground rods or a ground mat may be used to obtain the required ground resistance.

(13) All metallic equipment & structures shall be connected to the grounding network.

(14) Survey and implementation of EMC/ EMI mitigation measures including earthing and Bonding limit induced emf within permissible limits on adjoining Electrical, Signal & telecommunication and any other installation.

(15) Contractor shall furnish a certificate to the Engineer to this effect to have complied all earthing and bonding requirements prior to commissioning of OHE.

8.20.5 The work includes the earthing and bonding of steel work.

(1) Connectors, Clamps and lugs shall be bolted to structures with bolts, washers & lock nuts.

(2) Earth Electrodes: shall be at least 1.5 m away from any structure so as not to interfere with its foundation. Each mast/portal/TTC of OHE shall be connected to 3.0 m long copper cladded steel rod buried in the ground 300 mm below the NGL through GI flat and fasteners.

(3) Connectors: Exposed and buried earth connections shall be of type and in conformity with IS 3043 - Code of practice for earthing.

(4) The earthing connections shall be through fasteners for exposed connections or shall use exothermic welding procedure.

8.21 RETURN CURRENT CONNECTIONS FOR Auto Transformer (AT)

8.21.1 The Traction return Circuit constitute a network of Rail, Negative feeder, AEW, BEC (if required), and interconnection between rail and then including Buried Rail to AT.

8.21.2 Return Current passing through the rails to the AT shall be routed through the buried rail at each location of Auto Transformer.

8.21.3 For this purpose, a steel rail (one being used for track) of minimum of 52 kg/m, length of 13 m shall be buried near the track at the above locations at a depth of about 1 m to form a part of the earthing system. The buried rail shall also be connected by means of at least two separate distinct connections made with steel armoured PVC insulated cables of adequate size to the traction rails. In cases where the feeding post is located separately, away from the traction substation, the buried rail shall be provided at the feeding post (where the midpoint of the auto-transformer winding at the substation is grounded). The connections shall be maintenance free, self-gripping type. Wherever, such bonds pass along or across the tracks, it shall be routed along the sleepers using proper fasteners and clamps so as to avoid any damage/disconnection during ballast screening or tie-tamping of the track.

8.22 Rigid Overhead Conductor System (ROCS)

8.22.1 Design Parameter

(1) **Type of overhead conductor system**

The Rigid Overhead Conductor system shall include 25kV High Rise AC overhead rigid conductor rail with contact wire, associated jumpers, support structures insulator and ancillary equipment.

(2) **Clearances - Minimum Electrical and Mechanical Clearance**

The minimum electrical and mechanical clearances shall not be infringed under the worst operating conditions of the overhead line equipment, the rolling stock and pantograph.

Minimum Electrical and Mechanical Clearance (mm)

Item	Normal inside Tunnel (mm)
25kV Live metal to earth static Dynamic (passing)	 250 200
Phase Difference (50 kV) Static Dynamic (passing)	 540 350

Gap at Insulated Overlap or air- gap on rigid OCSbetween conductors of different electrical sections	400
Gap at Uninsulated Overlap or expansion joint on rigid OCS	200

The minimum clearances inside the tunnel for 25 kV traction are those specified in IEC 60913 with latest amendments.

The values shown in the Table above shall be used as a minimum. In the event of additional space being available, the space shall be used to enhance the electrical clearances above the stated values, before consideration is given to increase the system height.

(3) **Rolling stock**

Maximum height of rolling stock is 6827 mm.

(4) **Height of rigid conductor rail contact wire**

Minimum Height of the contact wire shall be 7184 from rail level.

(5) **Stagger of rigid conductor and contact wire**

Stagger of rigid conductor contact wire shall be limited to 200 mm, from rail centre on tangent track. On curves, value of stagger shall be submitted by Contractor based on pantograph profile. The design of ROCS shall permit a displacement of track by 50 mm horizontally without need for changing any component.

(6) **Permissible gradient of contact wire**

Gradient of contact wire shall be not more than 1mm/m on main tracks and not more than 2mm/m in loop lines.

8.22.2 Supporting structure

(1) **Safety of supporting structure**

Supporting steel structure for overhead contact system shall have a safety factor not less than 3 times yield point strength of steel against dynamic operational loads. Grouting shall be designed with a factor of safety as 4 and shall be load tested individually.

(2) Anchor plug and anchor bolt/ Chemical fasteners of supporting fixture.

Anchor bolt shall be installed for the supporting fixtures of rigid conductor rail at intervals finalised on basis of detailed design. The type of bolts and chemical fastener shall also be finalised on basis of detailed design. The supporting fixtures shall have facility of adjustment so as to install the ROCS at the designed height with the requisite stagger of the conductor rail. Yielding point strength of the fixtures and fitments shall have adequate factor of safety, considering worst loading/torsion conditions and dynamic loading on account of pantograph thrust and movement. The Contractor shall furnish the supporting design details for approval of the Engineer.

(3) Supporting steel fixture

The supporting steel fixtures (Drop Tube) shall be provided at suitable intervals, which are fixed to the tunnel ceiling by anchor bolts, based on design consideration. The interval between successive fixtures shall not permit undue sag and vibrations. The sag shall be less than 12 mm in the conductor rail span (RDSO Instruction No. TI/IN/0041, September, 2022 : Guidelines for ROCS for use in tunnels). The contractor shall furnish the supporting data of similar systems, which may have been provided by the contractor on other Railway Tunnel System/Metro System with 25kV AC rigid OCS, for the same speed potential. The steel work shall be hot dip galvanized and the nuts, bolts and washers shall be G.I/stainless steel of suitable grade for moist and polluted tunnel atmosphere.

(4) **Support Insulator**

Type of OCS support insulator to be provided shall be proven and shall meet the CAC. The electrical and mechanical properties of support insulator for the 25 kV High Rise AC rigid conductor shall be in accordance with the recommendations of IEC 383 / 1109. The minimum creepage distance of the insulator shall be 1100 mm, wet power frequency withstand voltage shall be 110 kV and dry lightning impulse withstand voltage shall be 250 kV in accordance with the recommendations of IEC 60913. The mechanical design should be proven to take the flexural stress to support the design. Supporting insulator fixture shall permit free sliding of Rigid conductor to allow for expansion on account of temperature changes.

(5) **Standoff Bracket (cross arm)**

This component is attached to the insulator through nuts and bolts. It is also known as cross arm. This has a long slot inside which provides the required stagger of ±200mm from the track centre axis. The length of the standoff bracket varies as per the requirement or site conditions. Like in case of overlaps, since parallel CRs are installed, the length of standoff bracket is lesser than the normal. Standoff bracket is always live.

(6) Swivel Head

This is provided in the slots of standoff bracket and can slide in the slots to achieve stagger of ±200 mm. Its main purpose is to hold CR and this allows free movement of CR due to temperature variations.

(7) **Preventing loosening of nuts and bolts**

Adequate measures shall be taken for preventing all bolts and nuts from becoming loose, by use of lock nuts/ spring washers.

8.22.3 Expansion Joint

Typical arrangement and Interval between expansion joints.

Expansion joints shall be provided at suitable intervals but the maximum interval may be allowed up to 500m depending upon the site condition.

(1) Parallel contact wires at expansion joint

Parallel contact wires shall be of adequate length to provide for suitable expansion joint assembly with provision for adequate number of flexible continuity jumpers. Separation distance between two ROCS sections at expansion joint shall not be less than 200 mm to ensure smooth passage of pantograph. No expansion joint shall be provided in the station area. Suitable gradient will be provided to ensure smooth change over. The expansion joints may be erected at site or prefabricated from the manufacturing works.

8.22.4 Sectioning Equipment

(1) Air-gap section

The structure of air-gap section shall be same as that of an expansion joint. At insulated air-gaps, separation distance between two ROCS sections at the overlap shall not be less than 400 mm, with two ROCS sections aligned such that pantograph passes satisfactorily. Air-gap sections shall be provided at the crossovers to segregate two sections. In case air-gaps are not found practicable, only in exceptional circumstances, the section insulators may be permitted.

(2) Jumper wire for rigid conductor

Jumper wires for rigid conductor shall be of stranded annealed copper with adequate current carrying capacity. Connection of jumper wire to rigid conductor rail shall bethrough suitable bimetallic terminals each having at least two fixing bolts. Bolts shall not conduct any current. Jumper wire shall be flexible to allow creeping of rigid conductor. The design shall ensure that the jumper loops remain at least 75 mm above the contact plane. The capacity of ROCS jumper wire shall be the same as that of the capacity of jumpers for flexible catenary and contact wire so as to flow transmission of full power. Jumper sizes and current carrying capacity shall not be less than as mentioned in RDSO Instruction No. TI/IN/0041, September, 2022 : Guidelines for ROCS for use in tunnels.

(3) Anchors

Anchors shall be provided for prevention of unidirectional creeping of rigid conductor rail.

(4) Location of anchoring

Anchoring shall be provided in the middle of one conductor run length between two expansion joints.

(5) Anchoring Insulators and Hardware

The design shall be such that the Insulator and hardware used at anchoring location shall be least affected by passing pantographs. Materials for anchors shall be corrosion resistant such as hot dip galvanized or of stainless steel. Suitable bimetallic fitment shall be integral with the hardware to prevent electrolytic corrosion to aluminium.

(6) Rigid conductor rail and contact wire

(a) Conductor rail shall be of Aluminium alloy section with wearing copper contact wire. Sections of conductor rails shall be joined together to form lengths up to 500m between two consecutive expansion joints. Contractor shall submit calculation of conductor length expansion for Engineer's approval. Contractor shall furnish the details of the conductor rail system offered indicating the life, speed potential of installation, strength and conductivity of joints, maintainability and the supporting details including performance of similar rigid conductor systems, if provided by contractor, on any other metro/Railway system. The lower side of the Rail has ribs on both sides for the contact wire insertion device which is used for inserting contact wire into conductor rail. To avoid bimetallic corrosion, the conductor rail profile design must not allow any condensation water to trip along profile and come in contact with copper profile interface. Contact wire is inserted inside the conductor rail profile and it is not mechanically tensioned.

(b) The copper Contact Wire shall be Hard Drawn Grooved Round Bottom, 150 sq mm area and material shall have temperature withstand capacity minimum 100^0C as per EN50119 and conforming to EN50149 or RDSO Specification No. TI/SPC/OHE/CW/0971 (latest).

(c) As Aluminium Alloy conductor rail will come directly in contact with the Copper contact wire, contractor will provide the mitigation measures to eliminate bimetallic/galvanic corrosion of conductor rail.

8.22.5 Standard length of conductor rail system and interlocking joints

(a) Standard length of conductor rail is generally around 10 metre. The span length of conductor rail shall conform to RDSO Instruction No. TI/IN/0041 of September, 2022 (Guidelines for ROCS for use in tunnels). However, the length offered by Contractor shall be supported by the calculations and the data of various metro systems using similar/same size rigid conductor OCS for the same speed potential.

(b) Interlocking joints are used for interconnection of two conductor rails. Interlocking joints are made up of same alloy as that of conductor rail and have similar physical properties. These rails are made continuous by Splices/Rail Joints. The conductor Rail (CR) Joint consists of inner and/or outer plates. The plates with their large contact surfaces ensure the current transmission between the rail and the joint and are also used for accurate mechanical fixing and fastening of the conductor rail. The interlocking joints have screw connections on each plate which allows faster construction and repair.

8.22.6 Protection cover for rigid conductor rail

There are possibilities of water leakage through nearest water body in the tunnel. Even though aluminium conductor rail is very robust to withstand climatic conditions, water seepage on the conductor rail cause problems. To avoid this risk, tunnel mouths and local moistures points and water leakage points, conductor rail is provided with a protective cover. Warning Boards shall be provided on the protection cover at 5m intervals. The material shall be Fire Retardant Low Smoke, Zero-Halogen (FRLSOH). Protection cover material & design and warning boards shall be submitted for approval of the Engineer. Contractor shall interface with civil tunnel contractor regarding water leakage areas.

8.22.7 Transition from Rigid to Flexible Catenary System

The transition from flexible overhead catenary system to Rigid overhead conductor system in the tunnels and vice versa shall be so designed that passage of the trains is as smooth as possible without resulting in any pantograph jerk, sparking and wear of components. The cross sectional area of copper (current carrying capacity) to remain the same throughout the installation. The design should be a proven design and should satisfy CAC. It is arrangement of joining ROCS with flexible OHE whenever track enters into underground tunnel or vice-versa. At the junction point of flexible OHE and the ROCS system, there will be a sudden change in the stiffness of the contact wire. The flexible OHE contact wire is tensioned but not rigid; whereas the contact wire of ROCS is not tensioned but clamped in rigid Conductor Rail. Thus, the movement of pantograph may not be smooth during the transition from flexible OHE to ROCS or vice versa due to this sudden change in the contact wire stiffness. Hence, there shall be a gradual equalization of the difference in stiffness between the flexible OHE contact wire and the ROCS contact wire to assist a smooth transition of pantograph. This is achieved by using the transition bar at the junction point. Transition bar is a piece of Conductor Rail with cut outs and these cut outs provide more flexibility and the transition bar acts as a shock absorber. At the junction point between flexible OHE and the ROCS system, the tensioned contact wire from Flexible OHE enters the ROCS system through the transition bar & anchor bar and gets terminated inside the ROCS system. The anchor bar is a normal conductor rail section only but it is provided with a number of bolts. The anchor bar is followed by the end point anchor arrangement. The endpoint anchor takes the tensile force of the contact wire entering the conductor rail and leads it into the civil structure. Thus, with the exception of the transition section, the contact wire in the conductor rail is not subjected to tensile forces. Contractor to design the transition arrangement and submit for approval of the Engineer.

8.22.8 Feeder for power supply to conductor Rail

A feeder cable (or flexible OHE wire) to supply power at 25 kV to from OHE to Conductor Rail (CR) and vice versa is required at the tunnel points. These 25 kV cables conforming to IEC-60840 are connected for transmission of power. At each CR joining point 2x240 sqmm copper armoured cables are terminated on copper busbar mounted on an insulator and then 4x150 sqmm copper jumpers are connected to Conductor Rail. Contractor to design the system for review of the Engineer.

8.22.9 Indicators Boards

(1) ROCS section indicator Boards shall be provided at approach to each electrical section of ROCS, which shall be visible to Train Operators (Drivers/Loco pilots) from an adequate distance.

(2) Number plates shall be provided at support locations, the numbering scheme to be adopted shall be submitted for review of Engineer.

(3) Warning indicator Board shall be provided at approach to termination of contact wire..

(4) "Warning: 25kV AC " Boards shall be provided at locations and intervals as decided upon by the Engineer. These boards shall be prominently displayed at regular intervals.

8.22.10 Earthing clamps

Wedge type PG clamps to be used for Earthing & bonding connections.

(1) **Earthing Clamp** - For maintenance activity on ROCS, discharge rods are connected on ROCS at the both ends of the section where work has to be done to ensure that the system has been completely grounded and no charge exists on the rigid conductor

system. The other end of the discharge rod is connected to the track rail or nearest earth point. Earthing clamps are fitted on the CR at the both ends of a tension length. These clamps provide proper fixing for the discharge rod. Discharge rod cannot be fitted anywhere directly on the conductor rail.

8.22.11 Aerial Earth Wire inside the tunnel

Aerial Earth Wire (AEW) shall run through the tunnel and contractor shall make proper mounting on the tunnel wall. All ROCS support brackets shall be earthed with AEW. At frequent intervals (not exceeding 400 m) the AEW shall be connected to the Tunnel Earth Wire (250 sqmm steel conductor).

8.22.12 Negative Feeder Wire inside the tunnel

Negative Feeder Wire (NFW) shall run through the tunnel. This shall be mounted on the tunnel wall with proper arrangements. Necessary clearances from tunnel wall and ROCS shall be maintained. The terminations shall be suitably designed with proper anchoring arrangement. The distance between the two mounting arrangements shall be such that NFW shall always remain above the contact wire of ROCS. The design shall be submitted for review of Engineer.

8.23 ROCS Contractor's Design Responsibility

8.23.1 Detailed Design of the ROCS

(1) Based on the survey of entire route, the Contractor shall offer the most suitable ROCS profile including ROCS sectioning and work out in detail the ROCS construction plan including return current longitudinal (continuity) and transverse (equalizer) bonding plan.

(2) The above application designs shall be based on standard arrangement Design principles and specially for**:**

a) OCS supports and spans, adequate common parallel run at expansion joint.

b) Arrangement of jumper connections at expansion joints and at feeder connections.

c) Transition arrangement with flexible OHE to be such that area of X-section remains the same throughout this section.

d) The insulator and OCS fittings must be able to take the flux stresses to accommodate train at design speed.

(3) (a)The components and fittings shall be of type and metallurgy, which are rust and corrosion proof. Steel components shall be hot dip galvanised. Nuts, bolts and spring washers shall be suitable grade stainless steel.

(b) The fittings, jumpers etc shall need minimum maintenance. Insulators suitable for humid and urban polluted atmosphere shall be used. The insulator shall be oil resistant and the surface finish should be such that least amount ofdust is able to accumulate on the insulator surface.

(c) The design shall be coordinated fully with the requirements of the signalling and telecommunication system, final track work, tunnel work, lighting system and any specified design requirements that those systems or facilities may dictate for the operation and management of the services.

(4) The Contractor may engage specialist subcontractor for ROCS work as per details given in Appendix-13 of GS.

8.23.2 Submittals

(1) Basic Design

Based on the basic designs worked out and route survey, the Contractor shall prepare and submit a detailed OCS final design, together with hardware applications design appropriate for the whole Project. The design of the support and anchor assemblies shall ensure adequate clearance from the pantographs under dynamic conditions. The Contractor shall select full range of proven ROCS components, and shall demonstrate by means of engineering calculations that all elements of the selected system are capable of meeting the Design Criteria, Safety, and Operational requirements. When computer programs are proposed for use, the Contractor shall submit typical hand calculations, together with comparable computer data input and output, for verification of the program, together with a description of the software.

(2) Drawings for review

Construction drawings shall be prepared and verified at site. The site verified plans shall be submitted to the Engineer for review. These shall include but not be limited to:

a) Schematic sectioning Diagrams.

b) ROCS construction Plans.

These shall include chainage of all support anchors and air gaps, height over rail level and other general particulars. On- site verification of the plans shall be carried out and based on final construction plan. OCS layout shall be finalized for construction.

c) ROCS layout plan:

Based on the finalised construction plan, ROCS layout plan shall be developed and submitted for review by Engineer. The ROCS layout plan incorporating following information shall be submitted:

i. The alignment of the conductor.
ii. Chainage of each support structure location.
iii. Exact chainage of all expansion joints, anchors and air gaps.
iv. Direction and value of stagger at each location.
v. Clearance of live conductors to fixed structures with respect to reference chainage.
vi. Alignment and layout of feeders.
vii. Jumper connections to switches and feeder tails.
viii. List of infringements, if any.
ix. Numbering of each support structure with respect to reference chainage
x. Location and serial number of isolator switches.

xi. Final Sectioning diagram drawn to a convenient scale showing identificationnumber of section insulators and elementary sections.

xii. Transition Element drawing (from Rigid OCS to Flexible OHE).

d) ROCS profile drawings

In case the height of contact wire is changed, an ROCS profile drawing showing the actual height of the contact wire at each location and the gradient adopted until normal height of contact wire is achieved.

e) As Built Drawings

Preparation of As-Built Drawing shall be part of this specification. As Built Drawing will be Final Drawings of the project showing the actual work done on a scale appropriate for the level of detail readily visible for review by the Approver .Normally part plans shall be prepared at A1 sheet and full scale plan A0 sheet.

8.23.3 Construction Requirement

(1) Track route and layout inspection and preparation of installation work

As preparatory work prior to installation, the location and position of supporting fittings, rigid conductor rail and anchoring shall be verified and marked at site. Height of the tunnel from top of rail at various locations shall be confirmed.

(2) Installation of supporting structure

((1) **Supporting structure**

Supporting anchor bolts shall be supplied and installed by the Contractor.

(2) **Supporting Insulator and accessories**

Supporting insulator and accessories for rigid conductor rail shall be mounted on supporting structure to enable adjustment of the conductor to required stagger as per the final design drawings.

(3) **Installation of rigid conductor and contact wire.**

Care shall be taken that no breakage, dent, crack or bending of any component takes place during transportation. Adequate care shall be taken to prevent any damage due to rust by applying rust prevention paint. Painting schedule to be submitted for review by Engineer. Materials delivered at work site shall be laid up neatly at nominated locations so that interference does not occur from other works going on nearby.

(4) **Installation of rigid conductor rail and contact wire**

Due care shall be taken while handling the rigid conductor rail that no twisting or bending or development of any crack takes place. Temporarily supporting the rail with one end cantilevering shall be prohibited. While installing the rigid conductor rail, safe practices shall be adopted.The erection of conductor rail shall be commenced from the anchor structure and continued on to the expansion joint.

Before installation of the end approach of expansion joint, adjustment of final length shallbe in accordance with the measured temperature in the tunnel. On curved track, the conductor rail lengths appropriately bent , with the approval of the Engineer, to requisite curvature taking into account track conditions and deviations of contact wire shall be provided. On turnouts the level of the crossover contact wire shall be raised so that it does not come in contact with train pantographs running on the main track, and for the trains negotiating the turnout, the passage and current collection by pantograph is smooth. Adequate tensile force shall be maintained in the contact wire. The Contractor shall submit the OCS installation plan to Engineer for approval.

(5) Jointing the rail

If the rail lengths are bolted together, the bolting process shall be of proven design with use of proven components.

(6) NFW mounting in tunnel and AEW clamping with tunnel.

8.23.4 Final Adjustment and Measurement of ROCS

After the equipment has been finally adjusted, the equipment shall be subject to final measurements jointly with the Engineer. The checks shall include but not be limited to:

a) Support location member, its height above rails level and stagger, gradients in ROCS.

b) Contact wire height at mid span between successive support members.

c) Anchors, expansion joints and air gap separations.

d) Clearance checks to ensure pantograph passing clearances, both electrical and mechanical clearance Pantograph test to ensure smooth shock free passage especially at section insulators at air gaps, at turnouts, crossovers and change of height of the contact system.

e) Fittings or jumpers and cable connection to:

(i) Overhead conductor rail

(ii) Return current circuit connected to running rails at regular intervals.

8.23.5 Site Testing and Inspection

(1) A detailed protocol for inspection and testing of complete ROCS shall be prepared and the tests and complete methodology for testing shall be submitted for review by the Engineer.

(2) **Installation checks and tests**

a) Visual inspection of overhead contact system installation, random check of components; electrical and mechanical clearances, air gaps and general alignment.

b) Continuity test of each joint in traction and return current circuit.

c) Insulation resistance of 25 kV ac overhead contact system shall be as per international standards.

d) Physical examination of rail bonds.

e) Checking of construction gauge

f) NFW continuity test, testing of joints.

g) Earth resistance test.

8.23.6 System Acceptance Tests

(1) Energisation

Each electrical section shall be energised successively at 25 kV ac from for one minute with adjacent sections isolated and connected to traction earth. Finally, entire section shall be energized for at least 24 hours.

(2) Short circuit tests shall be carried out as per a detailed test protocol, which shall be submitted for review by Engineer.

8.23.7 Integrated Testing and Commissioning

(1) All the items of supply and required for completion of the work in all respects, testing and commissioning of the OHE system as well as associated works and ROCS, for facilitating trial run of the rolling stock and Integrated Testing and Commissioning shall form part of the work covered by the contract whether specifically stated or not.

(2) During train trial contractor shall be responsible for providing and fixing discharge rods during power block permission/Cancellation before Revenue operation.

(3) High speed tests shall be carried out by means of running the trains initially at slow speed, then increasing the speed in stages up to full speed permitted for the section. On successful completion of the high speed tests, the ROCS shall be declared fit for pre- revenue system tests.

(4) The Contractor shall be required to operate and maintain the OCS until Taking Over by the Engineer.

8.24 INTERFACE COORDINATION BY THE CONTRACTOR

8.24.1 Design Coordination and Interface

The Contractor shall be responsible for design coordination for EMI and safety works related to rendering the whole installation safe from EMI interference (including twin tunnels) and from unsafe touch potential from induction effects of AC traction currents with the Civil Contractor and through the Engineer with adjacent DFCCIL and Indian Railway system of both electrified and non-electrified sections, if any.

(1) The Contractor shall be responsible for coordinating the final OHE & ROCS design and installation at different stages of design and construction in co-ordination with Civil and S&T contractors.

(2) The Contractor shall be responsible for Interface with the DFCCIL and Indian Railway.

(3) The Contractor shall also interface with Indian Railways (IR) through the Engineer as follows:

(a) For the design, construction, testing and commissioning of the overhead line at the Stations linking with IR. .

(b) To ensure that the design and construction of the OHE does not affect the signal sighting on Indian Railways.

(c) To ensure that the construction of the OHE does not interfere with train operation on Indian Railways nor damage any Indian Railway assets.

(d) To ensure that the design and construction does not impede the operation and maintenance for Indian Railways, in any way.

(4) The contractor SYS-1 shall provide protective screens for works like new/extension of ROB/ FOB etc along with earthing and various warning & danger Boards. The Contractor shall interface and coordinate with the civil contractor regarding progress of ROB/FOB etc. The contractor shall also coordinate with civil contractor for removal of trees from any work site of TSS/SP/SSPs which shall be removed by the Civil contractor.

(5) The contractor shall coordinate with Civil contractor for Connection with Rail ensuring smooth flow of traction return and fault current back to TSS from the bridges and for ensuring safe touch and step potential under all conditions and shall execute all the necessary works.

(6) Contractor shall coordinate with civil and S&T (signal and telecommunication) contractor regarding construction of Level Crossing LC). The Height Gauge at LC gates shall be installed by the Civil Contractor along with provision of warning and danger boards and their earthing. Contractor shall interface with civil contractor for provision of warning and danger boards etc.

8.24.2 Tunnel works interface

Contractor shall interface with civil contractor for all tunnel works i.e provision of ROCS support steel fixtures, AEW and NFW mounting, protection screen on Conductor Rail etc.

8.24.3 The interface requirements to be met by the contractor have been defined in chapter 18 of these Specifications.

(End of Chapter 8)

CHAPTER 9 - LV SUPPLY AT TRACTION SUPPLY POSTS AND S&T INSTALLATIONS FROM 25KV/240V AUXILIARY TRANSFORMER

9.1 GENERAL

240 V, single phase, LT power supply for Switching posts and Stations and for other S&T installations shall be through Auxiliary Transformers.

9.2 SOURCE OF SUPPLY

240V, single phase, LT supply at TSS, SP and shall be obtained by suitably installing 25kV/240V, single phase auxiliary transformer of the following rating:

(1) TSS (each) — Two 100kVA Auxiliary Transformers connected to 25kV bus bar.

(2) SP and SSP — One 25 kVA Auxiliary Transformer on UP line and second on DN line at each switching station connected to 25kV bus bar.

(3) The connection shall be such that in case of power block or failure of power supply on any one of the lines, the LV power shall automatically switch over to the other line.

9.3 LV SUPPLY AT STATIONS AND S&T INSTALLATIONS

9.3.1 The emergency power shall be made available for essential loads by the contractor by installing 25kV/240V, Single Phase, 50 kVA auxiliary transformer at 4 crossing stations and 25kVA (minimum) step down transformers at other stations. The LT cabling from the auxiliary transformers shall be terminated at the automatic change over switch located in Station as required. The connection for such emergency supply shall be arranged as per the requirement for various station / Rooms.

9.3.2 For Telecom installations and LC gate along the route, supply from 25kV/240 V, Single phase (10 kVA minimum) Auxiliary Transformers, shall be the main source of supply and shall be provided by the contractor including laying of LT cables and provision of Automatic Changeover (ACO) switch. The connection for such emergency supply shallbe arranged as per the requirement for various equipment Rooms. The Cable crossing required (if any) under the track shall be suitably protected through conduits / pipe as stipulated in ACTM and track crossing regulations. The Contractor shall provide the same in coordination with the Civil Contractor.

9.3.3 The Cables shall be laid from the output of secondary side to the Automatic change over switch (ACO) installed in the ASM's room or Telecom huts in the Prithla – New Harsana Kalan section.

9.3.4 The auxiliary transformer losses shall not exceed as per specified criteria of BEE for 5 – star rating.

9.3.5 The Auxiliary Transformers shall conform to specification no. ETI/PSI/15(8/03) and mounting arrangement shall be similar to ETI/PSI/0312 (Mod. B). The efficiency of the auxiliary transformer shall be governed by the total losses at 50% and 100% loading as per the formula given below:

$Y_0 50\% = (K_{Xo\ \%\ and})/(K_{X2\ \%\ and})\ X((L2\text{-}L1) + M_1\ X_1$

$Y_0 100\% = (K_{Xo\ \%\ and})/(K_{X2\ \%\ and})\ X((L2\text{-}L1) + M_1\ X_1$

Where :
K = kVA rating of transformer
L = losses
M1 = Maximum losses for a given star rating
Xo = kVA rating of Standard Rating Transformer
X1 = kVA rating of Standard Rating Transformer below Xo
X2 = kVA rating of Standard Rating Transformer above Xo
L2 = Maximum losses for a given star rating Standard Rating Transformer above Xo@ a particular loading
L1 = Maximum losses for a given star rating Standard Rating Transformer below Xo@ a particular loading
M1 X1= Maximum losses of X1@ a particular loading for a given star rating

(End of Chapter 9)

CHAPTER 10 - SUPERVISORY CONTROL & DATA ACQUISITION (SCADA) SYSTEM

10.1 GENERAL REQUIREMENTS

10.1.1 This Chapter of the Particular Specifications defines the objectives, guidelines and requirements for the Contractor's design, manufacture, supply, installation, testing and commissioning of field side equipment and integration of Supervisory Control and Data Acquisition (SCADA) system for Prithla to New Harsana Kalan section. The Prithla – New Harsana Kalan section wherever mentioned shall also include all the connections of HORC line with IR i.e (1) from New Patli station to Sultanpur station (IR) and Sultanpur station (IR) to Badsa with SP at Sultanpur station (IR); (2) from Mandothi station to Asaudah station of IR with SP at Asaudah station (IR) and (3) New Harsana Kalan to Harsana Kalan station (IR) with SP at New Harsana Kalan station and also connection of HORC line from Prithla to New Prithla station of DFCCIL with SP at Prithla and connectivity of Prithla (HORC) with Prithla (DFCCIL). All the SCADA provision for the entire section shall be under the scope of Contractor SYS-1.

10.1.2 The architecture of the SCADA systems and the OCC equipment shall allow to control and monitoring of the traction power supply installations for the Prithla to New Harsana Kalan. Therefore, the Contractor is responsible for Design and Installation of Control and Monitoring equipment including work station in the OCC for the entire section.

10.2 Scope of Works

10.2.1 The Scope of works to be executed under this Contract Package SYS-1 includes design, manufacture, supply, installation, testing, integrated testing and commissioning of traction SCADA for Prithla to New Harsana Kalan Section and also switching stations of lines joining IR, are as below but not limited to:-

(1) Remote monitoring and control of 220/132 kV TSS,

(2) Remote monitoring and control of Traction Substations (TSS),

(3) Remote monitoring and control of Sectioning Posts (SP),

(4) Remote monitoring and control of Sub Sectioning Posts (SSP),

(5) Remote monitoring and control of standalone Auto Transformer Stations (ATS) if required as per traction simulation studies and duly approved by the Engineer,

(6) Remote monitoring of power supply status of Auxiliary Transformers (ATs) at all stations (17 nos. from Prithla to New Harsana Kalan and Sultanpur & Asaudah) provided enroute through Traction Power SCADA system.

(7) Remote monitoring and control of switching stations of lines joining IR at Sultanpur, Asaudah & New Harsana Kalan and motorized Isolators at Sultanpur, Asaudah & New Harsana Kalan yard OHE. Remote monitoring and control of switching station of lines joining DFCCIL at New Prithla.

(8) Monitoring of above TSS, Switching posts etc which shall include all switches such as Circuit Breakers, Interrupters, motorized Isolators etc,

(9) The monitoring includes acquisition of data such as Voltage, Current, kVA, power factor, Maximum demand, Energy etc. with recording facilities and storage of data for a period of 3-Months time.

(10) OHE Catenary Indication with auto fault localization and isolation of faulty section with monitoring fault locations as triggered by Fault Locators acting on the algorithm and logics as approved and compatible for reporting to the OCC.

(11) Monitoring of traction return current shall provide measurement of following:

a) The traction return current returning from the Earth (connection between the bus bar and the Traction Power Feeder grounding system), and

b) The total return current of each main transformer and auto transformers flowing through the cables between the bus bars and the transformers.

(12) Provision of control & data cable network and cable containment arrangement at the following locations:

(a) TSS, SP, SSP, SS, Auxiliary Transformer locations and ATS if any; and Switching stations (1x25 kV) at 2 locations;

(b) Low Voltage AC and DC power supply wiring at TSS, SP, SSP, SS, Auxiliary Transformer locations and ATS if any;

(c) All Traction Power SCADA control and power supply cabling within OCC.

(d) Where cables cross the track or are external to cable trench routes, then these shall be suitably laid through the Pipes as stipulated in IS 1255, ACTM and track crossing regulations. The Contractor shall coordinate with the other Contractor and provide the same. The Under track crossing conduits shall have a Cable pull pit of size and arrangement as approved by the engineer at both the ends to facilitate cable laying & pulling.

(e) Provision of cable termination boxes at RTU locations and at OCC for OFC Cables, where cables enter and leave the equipment room.

(13) Protective provisions relating to electrical safety and earthing of SCADAequipment which include earthing of equipment, cables and non-current carrying metallic components, etc.

(14) Monitoring of check metering at TSS to register all the Energy parameters similar to those measured by Power utilities,

(15) Provision of Web server with appropriate security (Firewall etc.) with capability for internet connectivity for access of HMI (only monitoring) from remote location, as required,

(16) The Contractor, shall provide OCC equipment (Server and Work Station etc) including adequate redundancy related to various field equipment for Prithla to New Harsana Kalan Section and also for connectivity with Northern Railway (at Patli, Sultanpur, Asaudah and Harsana Kalan stations). The SCADA equipment RTU etc at Patli SP shall be provided by other OHE contractor but all equipment at OCC for control and monitoring of Patli SP shall be provided by Contractor SYS-1.

(17) The Video wall for displaying the status of equipment at OCC for the Prithla to New Harsana Kalan Section shall be provided by the Contractor under Contract Package-SYS-1. The Contractor shall display SCADA information on Video wall for the entire Prithla to New Harsana Kalan Section and also for connectivity with Northern Railway at Patli, Sultanpur, Asaudah and Harsana Kalan stations.

(18) The communication link between Substations, Switching Stations, ATs, Stations, stations and Depot (IMD & IMSD) with OCC through an optical fiber cable (OFC). The provision of OFC for Prithla to New Harsana Kalan Section and for connectivity with Northern Railway (at Patli, Sultanpur, Asaudah and Harsana Kalan stations) and with DFCCIL at New Prithla shall be required. The communication link with OFC shall be provided by Signalling and Telecommunications (S&T) Contractor. The Contractor (SYS-1) shall interface with S&T contractor for ensuring proper telecommunication link, as required.

(19) The Contractor (SYS-1), shall interface with Northern Railway (NR) for ensuing provision of OCC equipment (Server and Work Station etc) in NR system including adequate redundancy related to various field equipment for switching stations having connectivity with Northern Railway (at Sultanpur, Asaudah and Harsana Kalan stations). Accordingly, the Contractor SYS-1 shall furnish the requirement and I/O List of control and monitoring signals to Northern Railway for successful integration of SCADA System at the OCC of NR. Contractor (SYS-1) shall also interface with DFCCIL for SCADA system integration (between HORC and DFCCIL) for Prithla to New Prithla section.

(20) The Contractor shall provide RTU and other accessories at 11kV/440V substation or 440V supply system at stations and tunnel for monitoring HTP, MDP, DG set, UPS (as required). There shall be 2 nos 11kV/440V substations for tunnel power supply system.

10.2.2 A comprehensive Scope of works under this present Contract Package SYS-1 forPrithla to New Harsana Kalan Section and the Works related to provision of Control & Monitoring Equipment in the OCC for the entire Section under Contract Package are summaries hereunder. :-

A) Detailed list of SCADA Equipment in the OCC provided by Contractor shall include but not limited to. :

(1) Operator Work stations at OCC for Prithla to New Harsana Kalan Section; and connections at New Prithla (DFCCIL), Patli (IR), Sultanpur (IR), Asaudah (IR) and Harsana Kalan (IR),

(2) Data Server, Application Server with 100% redundancy for this section.

(3) Separate Communication Server with 100% redundancy for this section

(4) All the Servers shall be configured in hot stand-by arrangement with 100% functionality,

(5) Training Simulator with minimum 5 no. training consoles at OCC for training of SCADA Operators and maintenance staff. The Training Simulator setup includes minimum Training RTU, Training Server, Trainer Console and Trainee Console.

(6) Provision of Network Switches with 100% redundancy at OCC,

(7) Provision of hot stand-by server at OCC.

(8) The OCC equipment shall be designed, supplied and commissioned for entire Section.

(9) The provision of interface hardware for SCADA information for real time projection on Video wall for the entire Section.

(10) OCC Equipment

(i) Communication and Application Server

(ii) Workstations for Control and monitoring, Report generation, Offline data analysis, Engineering, Maintenance and RTU configuration

(iii) Archive and Webserver

(iv) Simulator System for Training

(v) Network Security and Monitoring System

(vi) Laser Jet and Line printer A3/A4

(vii) Communication and dual LAN equipment

(viii) Mounting brackets, equipment cabinets, racks, installation materials

(ix) Server Room furniture with proper storage for spare material as required

(x) Power Extension from the UPS, cables, connectors, accessories, cabling and earthing necessary for the works

(xi) Other equipment as necessary to fulfil the requirement

(11) Detailed list of Field equipment for SCADA provided by Contractor but not limited to:

a) Remote Terminal Unit (RTU) and associated communication equipment

b) Local Interface Unit (LIU) at TSS for Local control

c) Cables, connectors, accessories, cabling and earthing necessary for the works

d) Portable configuration and Fault Diagnostic devices - One number for each IMD and two numbers for OCC.

e) Data Communication Network:

(i) The provision of network within TSS, SP, SSP, SS, AT and ATS if any,

(ii) The Contractor shall establish the communication network from different Power supply installations for the present section.

f) Any other works/equipment to fulfil the specified requirement,

10.2.3 An indicative conceptual system configuration for the SCADA system Prithla to New Harsana Kalan Section is attached in Part 2, Section VII-3 and included in the bid documents.

10.2.4 **Emergency Power requirement for calculating Rating of UPS**

(1) Emergency power supply at OCC for SCADA system shall be provided by the Contractor by 2 nos. independent online UPSs.

(2) Each UPS shall have minimum 120 minute Battery power backup capacity.

(3) UPS 'Emergency Power supply' for SCADA at Stations, depots as applicable including Control Room Buildings (TSS, SSP and SP) for Traction & Auxiliary SCADA load etc. as approved by the Engineer shall be provided.

10.2.5 The design and installation of SCADA equipment shall be based on this particular specification (PS) and based upon best engineering practices and conforming to the following specifications, IEC/EN/ISO/Indian equivalent standards:

[IEC 61508]	Functional safety of electrical/electronic/programmable electronic safety related systems
[EN 50126]	Railway applications – The specification and demonstration of Reliability, Availability Maintainability and Safety (RAMS) [IEC 62278 series]
[IEC 62443-5]	Industrial communications networks – Network and System Security – Security for industrial automation and control systems – Part 5: Technical security requirements for industrial automation and control systems
[IEC 62236]	Railway Applications – Electromagnetic Compatibility
[EN 50121]	Railway applications - Electromagnetic compatibility
[EN 50011]	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical radio frequency equipment
IEC 61000-4]	Series of standards - Electromagnetic compatibility – Generic standards – Testing and Measurement Techniques
[IEC 60870-2-1]	Tele-Control equipment and systems- Operating conditions – Power Supply and electromagnetic compatibility
[IEC 60870-2-2]	Tele-Control equipment and systems- Operating conditions – Environmental Condition.
[IEC 60870-5-1 to 5]	Series of Standards - Tele-control equipment and systems- Transmission protocols
[IEC 60870-5-101]	Tele-control equipment and systems- Transmission protocols - Companion standard for basic tele-control tasks
[IEC 60870-5-103]	Tele-control equipment and systems- Transmission protocols - Companion standard for the informative interface of protection equipment
[IEC 60870-5-104]	Tele-control equipment and systems- Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles
[IEC 61850]	Series of Standards - Communication networks and systems in substations
[IEEE 802 series]	Local Area Network
[IEC 61131-3]	Programmable Controllers – Programming Language
[IS:6911-1992]	Specification for Stainless Steel and Strip
[IEC 60297]	Specification for 19-inch rack
[IEC 60529]	Degree of protection provided by enclosures (IP Code)

[IEC 62040]	Specification for UPS
[IEC 60146]	Specification for Semiconductor Converter
[IS 694]	PVC Insulated cables for working voltages up to and including 1100 Volts.
[IS 1554-Part I]	PVC Insulated Cable (Heavy Duty) Electric Cables
[IEC 60255-5]	Insulation coordination for measuring relays and protection equipment – Requirements and tests

[IEC 60255-21]	Vibration, shock, bump and seismic tests on measuring relays and protection equipment
[IEC 60255-22]	Measuring relays and protection equipment - Part 22-5: Electrical disturbance tests
[BS 6651]	Lightning Protection
IEC 61643	Components of low-voltage surge protection devices
IEC 61312	Protection against lightning electromagnetic impulse
IEC 61024	Protection of structure against lightning
[IS 3043-1987]	Code of Practice for Earthing
[EN 50122-1]	Railway applications - Fixed installations - Protective provisions relating to electrical safety and earthing
[BS 7671-2001]	Requirement for wiring Installation, IEE Electrical Wiring Regulations 17^{th} Edition.

10.3 DESIGN CRITERIA

General feature and basic design requirement for SCADA equipment at the OCC and at the field Equipment are as under:

10.3.1 Basic Design Requirements

The Contractor shall examine the scope of work and scrutinize the specified system, specification for cables and equipment and work out the ratings and capacities based upon his own designs, for approval of the Engineer. The design of the system, including all sub-systems and equipment shall be evolved based on principles as indicated in clause 4.4 along with the following additional principles:

(a) Adequate redundancy in system such that any single point failure shall not degrade the system availability or performance of SCADA equipment in any way; the second level of failure shall be able to meet with crisscross redundancies.

(b) Ergonomically designed to ensure no long term fatigue or cumulative injury to the operators;

(c) Adherence to operational performance requirements;

(d) The SCADA equipment shall meet the environmental conditions as below

Minimum Temperature	: $5^{o}C$
Ambient Temperature	:$29^{o}C$
Maximum Temperature	:$35^{o}C$
Relative Humidity	: Minimum 0%, Nominal 65%, Maximum 95% (Non Condensing)
Electrical Noise	: High Frequency to 1MHz, 1kV damped to 50% after 6 cycles.
	: Radio Frequency field strength 10 V/m, UHF & VHF bands.

(e) SCADA equipment shall be self-monitoring i.e. failure of any piece of equipment down to the individual RTU Card level (I/O card, Power conditioning, Controller card etc. as applicable) shall cause an alarm locally and as well as at the OCC.

(f) The SCADA architecture shall permit up-gradation of I/O numbers upto 20% to include more controlled switching stations / additional equipment.

(g) SCADA equipment shall incorporate hardware and software for Multi-tier access control features as per the allowed level of Command that prevents access by unauthorized persons; the unsuccessful login shall be alarmed and logged at OCC. Unsuccessful Entry Access to the SCADA rooms at TSS, SSP and SP shall also be logged and alarmed at OCC.

(h) Any equipment manufactured shall have its failure rate determined strictly in accordance with its appropriate operating environment.

(i) In rare instances failure of a single item of equipment may be tolerated for a short period of time provided that only a small part of the overall system is affected and the occurrence does not take place more than once per year. However, redundancy shall be incorporated where failure cannot be tolerated even for short periods.

(j) Noise

All SCADA system equipment shall operate satisfactorily in the very high "electrical noise" environment normally associated with Freight systems due to electrical fields created by traction supplies and strong magnetic fields. Equipment shall be immune to the effects of conducted and radiated electrical interferences.

The SCADA equipment shall comply following CE norms:

Standard	Norms
EN55022	Electromagnetic Interference
EN55024 (IEC 61000-4-2,3,4,5,6,8,11)	Electromagnetic Immunity
EN 61000-3-2 (IEC 61000-3-2)	Power line harmonics
EN 61000-3-3 (IEC 61000-3-3)	Power line flickers
EN60950 (IEC 60950)	Product Safety

(k) Lightning Strikes / Power Supply Surges and Disturbances

(i) The design shall ensure that all SCADA equipment are fully protected against the effects of power supply surges and direct and indirect lightning strikes and provided with lightning Protection Units.

(ii) Lightning protection systems/ units shall be in accordance with BS 6651 —"Lightning Protection" or any equivalent Indian/ International Standard.

(iii) All surge suppression equipment shall be self-contained and self-resetting. The suppression equipment shall be so selected that the let-through voltage specification does not exceed the absolute maximum voltage specified for the particular equipment being protected.

(iv) Signal lines from external sensors / transducers etc. at risk from the effects of lightning shall have surge suppressers fitted at both ends and shall be installed and connected in accordance with the manufacturer's recommendations.

(l) The Scope shall include any equipment for the systems and the sub systems, necessary for the complete, safe, reliable, operable and maintainable SCADA equipment.

(m) The design shall employ the quality procedures and best practices for selecting the equipment. It shall be possible to replace the faulty unit instead of whole equipment.

10.3.2 Modular Equipment and Components

(1) To the extent possible all components shall be modular in construction to facilitate easy troubleshooting and replacement of components to minimize down time of the system. Where equipment is of the same type, rating, equipment shall be interchangeable.

(2) Open systems shall be employed such that if items from one supply becomes economically unviable or non-available, products from other suppliers will be available and compatible. The contractor shall furnish the list of Equivalent cards of all types of cards installed.

10.4 DOCUMENTATION SUBMISSION REQUIREMENT

Documents to be delivered by the contractor shall include but not limited to the following:

(1) Design stage

The Contractor shall design the SCADA equipment as per the designrequirements. These shall include but not limited to:

(a) SRS on the SCADA equipment,

(b) SCADA architecture,

(c) RTU Drawings and HMI Design Documents,

(d) Input/Output (I/O) list,

(e) Control and Logics of each operation,

(f) Proven-ness certificates / evidences of Proven & Satisfactory Performance

(g) Proposal of SCADA equipment ratings and makes in the required format as prescribed by The Engineer;

(h) Calculation of Conductor sizes and core numbers for all control cables for SCADA,

(i) Identification of the bandwidth required,

(j) Earthing requirements, calculations of safe touch and step potentials for the SCADA Equipment and EMC Control Plan for SCADA, ,

(k) RAMS requirement with MTBF and MTTR and the V&V matrix for each module,

(l) Type test reports for equipment or components selected for SCADA,

(m) Design requirements taking into account Human Factors and Work Load Assessments at OCC.

(n) Hardware and Software Obsolescence management plan,

(o) Interface management plan, includes interfaces with other sub- system/ contractors/other sections of HORC,

(p) Factory Test, Site test, Integrated test plan, Identification of System critical parameter,

(q) Control and Logics of the fault localization in different failure scenarios or faults at different points in OHE system and shall submit as a separate diagnostic module,

(r) Fault diagnostic module for hardware/software faults,

(s) Modules on various utility Program which may be required by the Operator/management to Capture Historical Data, Trend, Demand control and Alarm Management including power Block management.

(t) The detailed procedure for switching from Main server to the other server at the OCC based on design of the SCADA system along with periodicity.

(2) Construction/ Installation Phase/stage

(a) Construction and Installation Plan;

(b) Quality Plans and RAMS Plans;

(c) Installation, operation and maintenance instruction of all equipment;

(d) Drawings of equipment;

(e) Inter-connection Drawings;

(f) As built Drawings including interface Drawings;

(g) Earthing and Bonding plans;

(h) Updated EMC Control Plan and certificates;

(i) Site access control system; Operation & Maintenance Manual with Fault diagnostic;

(j) List of installed Spares, spare space in the cubicles, Mandatory spares as delivered and recommended spares.

10.5 CONTROL AND MONITORING REQUIREMENT

10.5.1 The SCADA system shall monitor & control the equipment at following as a minimum:-

(1) Traction Substations;

(2) Sectioning Posts;

(3) Sub-Sectioning Posts;

(4) Stand alone Auto Transformer Stations if needed as per traction simulation study;

(5) Protection system;

(6) Measurements at required points;

(7) Fault locators, Power Quality equipment(s) etc.;

(8) Motorised Isolators and Interrupters in stations/ yards;

(9) Monitoring of Auxiliary transformer(s) Power supply at TSS, SSP and SP including those provided for stations.

(According to indicative designs, the location of the principal sites to be controlled and monitored is shown in Part 2, Section VII-3: drawings).

10.5.2 The Contractor shall confirm the exact number and configuration of each type of switching station (TSS/SSP/SP) as part of the works described in this Particular Specifications.

10.6 INDICATIVE LIST OF EQUIPMENT TO BE MONITORED AND CONTROLLED AT REMOTE LOCATIONS

10.6.1 Table 10.1.1 provides an indicative overview of the typical items of equipment that will be required to be monitored and controlled in each Installation on Prithla to New Harsana Kalan section of Package SYS-1 of HORC Project. The list is not exhaustive and may not cover all the equipment and functionalities. The Contractor may be required to provide functionalities, Monitoring & Control of additional Analog & Digital I/O points as required by the Engineer.

Table 10.1.1

INDICATIVE LIST OF EQUIPMENT TO BE MONITORED AND CONTROLLED AT REMOTE LOCATIONS

Equipment	TSS	SSP	SP	SS at Station (If any)	Stations
Traction Transformers and Power Transformers	√	0	0	0	0
Auto Transformers	√	√	√	0	0
DP Circuit Breakers for 2x25kv AT System	√	√	√	0	0
DP Interrupters for 2x25 KV AT system	√	√	√	√	√
Motorised DP Isolators for 2x25 KV AT system	√	√	√	√	√
Motorised SP Isolators for 2x25 KV AT system	0	0	0	0	√
LA on secondary end of Transformer	√	√	√	√	0
132 kV Circuit Breakers	√	0	0	0	0
132 kV Motorised Isolators	√	0	0	0	0
LA on Primary Side of Transformer	√	√	√	0	0
Power Quality Improvement Equipment	√	0	0	0	0
Battery Chargers	√	√	√	√	√
Auxiliary Transformers	√	√	√	√	√
Low Voltage Distribution Boards	√	√	√	√	0
Current and Potential Transformers	√	√	√	√	0
Doors and gate contacts	√	√	√	0	0
Intruder alarms	√	√	√	0	0
Access control system	√	√	√	0	0

Fire alarm system	√	√	√	0	0
Automatic fault Locator	√	√	√	0	0
UPS	√	√	√	√	√
Video Surveillance System	√	0	0	0	0
11kV/440V power supply system (HTP, MDP, DG set) including tunnel substaions.	0	0	0	0	√
Tower wagon shed Gate	0	0	0	0	√

10.6.2 The contractor (SYS-1) shall asses the requirement of Monitoring & Controls, Measurements as required and prepare an exhaustive list of I/O points, Tele-commands, Tele-signals and Measurands needed during full lifecycle with additional 20% requirement for future extensions and shall seek the approval of the Engineer during Initial stage of Design finalization. The decision of the Engineer on the level of monitoring, Controls and Measurements of Various parameters shall be final.

10.6.3 The SCADA system installed at all TSS shall be uniform with highest I/O points as required for TSS with required spare and installed Transformers / Equipment.

10.6.4 Above table includes Intruder Alarms and Access Control system status and alarms. The specifications for these items are covered in the Telecom Works for Intruder Alarm. The status of supply for Auxiliary Transformers provided at Power supply installations of TSS, SSP and SP Installation to be included in the Traction SCADA.

10.6.5 The SCADA system shall be integrated with the smart card based Access Control and maintenance locking off system provided in Traction Power Supply Installation premises.

10.6.6 The SCADA system shall be integrated with fire control system to notify SCADA Operator for any untoward fire situation at traction power supplies installation.

10.6.7 The video Surveillance system, under the scope of Package SYS-1 contractor for Pirithla – New Harsana Kalan Section, shall provide effective real-time video surveillance of the Traction Substation from OCC. The equipment shall be provided by Contractor SYS-2 (S&T contractor) and necessary interface shall be done. The contractor shall arrange the video Surveillance for the following::

a. Main Entrance gate,

b. Incoming Bay area,

c. outgoing bay area,

d. Transformer area and,

e. Power Supply Control room Building Area

10.6.8 In addition to the above, the Contractor SYS-1 shall provide of one additional Client PC workstation with 21 Inch full HD LED backlit colour monitor for viewing, monitoring and management of Video Surveillance Data at the Traction Power Controller (TPC at OCC control room) as required and specified by the Engineer.

10.7 PERFORMANCE REQUIREMENTS

Performance requirement for SCADA equipment in the OCC and at the fields' level are being specified hereunder..

10.7.1 The SCADA system shall be fully equipped with all cards and command levels for both the TSSs and associated bay equipment.

10.7.2 The SCADA systems shall continue to be able to function should there be a mass trip of all equipment at every TSS, SP, SSP and SS. The OCC shall continue to function normally in such an event. The Server, Work Station and RTU processor and memory usage should not exceed 60% during Mass trip.

10.7.3 Complete SCADA system with servers, workstations, and full communication with all RTU's shall be ready within 15 minutes of a cold restart of complete system. All software shall automatically start up on system restart and system shall be ready for the operator after entering the password/ other security Check like Finger touches/ face recognition.

10.7.4 The SCADA system shall be able to initiate a change of state at the output of an RTU within <1 second of initiation by the control room operator. If this change has not occurred in the field for any reason, the operator shall be notified that the command was unsuccessful. The Contractor shall demonstrate the past performance of similar system provided elsewhere by them with client's Certificate while proposing for implementation on HORC as per the Scope of work.

10.7.5 The SCADA system shall indicate the change of state or change in alarm status within <1 second of receiving the signal at the input to an RTU.

10.7.6 The Total time of any commanded operation including all propagation delays shall not be >2 second i.e. from Initiation to receipt of Confirmation at work station.

10.7.7 The SCADA system shall be capable of time stamping with a resolution in conformance to IEC 60870-5-104 and IEC 61850 as required.

10.7.8 The SCADA system at OCC shall support data acquisition from RTU or other IED over Ethernet based IEC 60870-5-104.

(a) Open protocol, with Ethernet can support time stamped Data streaming, clock sync;

(b) Shall support Ethernet IEE802.3, X.21 and Ethernet;

(c) Shall Support Data Link Layer- IP (RFC 1661), RFC 894), Ethernet II, IEEE802.3;

(d) Shall Support Network Layer- IP (RFC 791),;

(e) Shall Support Transport Layer- TCP (RFC 793)/ UDP;

(f) Shall Support Application Layer – IEC 60870-5-104;

(g) Shall Support -Point to Point, Multipoint, Star, Ring Topology.

10.8 RAMS REQUIREMENTS

The RAMS shall conform to EN 50126 / IEC 62278 -.The contractor shall design the SCADA system to meet the RAMS targets specified for the system.

10.8.1 Reliability Requirements

(a) The SCADA system shall be of the highest reliability. The OCC equipment shall have 100% redundancy as a minimum.

(b) In the event that if SCADA system fails then the traction power and its protection system shall continue to operate autonomously, until either the SCADA system comes on line or until the switching station is placed into local control.

(c) All OCC equipment shall be supplied power from two independent sources of supply.

(d) The design shall consider Multi-tier, Multiuser Security at server level, Operator Work station and backup storage of data in SCADA.

(e) Single point failure should not impact the SCADA performance.

10.8.2 Availability Requirement

The SCADA system shall be designed to achieve at least the following levels of system availability:

(a) The complete SCADA system shall be designed to meet 99.99% hardware availability.

(b) The availability figures for Traction Power functionality and the Traction power decision support system shall be 99.97%.

(c) In determining the availability of the Delivered System, Reliability Block Diagrams using expected failure rates for off the shelf equipment shall be produced.

(d) The System shall be designed to ensure that failure of any major equipment, caused by external accident or negligence of the internal staff or malicious damage by external influences or fire will not lead to unavailability of the whole system, other than a temporary outage of the failed equipment. For this purposethe SCADA system shall provide through pre-determined algorithm the steps to be adopted by the Controller to retain the system in healthy condition to the extent feasible.

(e) In event of communication failure at any control Post, the particular post shall record changes within the switching station until communications are restored and RTU shall update current status and change history shall be transferred to the master station for recording in the logs of Events.

(f) The Contractor shall prepare a detailed maintenance strategy for the SCADA system, detailing how system availability will be maintained.

10.8.3 Maintainability Requirement

The SCADA shall employ a unit spare replaceable based maintenance methodology. The Fault diagnostic software shall be able to diagnose and report the SCADA module (I/O Card, Controller card, Communication Port, Power Supply Unit card failure. The SCADA system shall have an MTTR of 30 minutes excluding the communication failure. This time shall not include the time taken for a maintenance staff to arrive at the initial reported failure site.

(a) The Contractor shall demonstrate that system maintains and fault diagnosticsability is sufficient to support the claimed system reliability and availability performance. The Contractor shall demonstrate that maintenance errors have been considered and risk of maintenance-induced faults has been mitigated in design.

(b) The equipment to be supplied by the Contractor shall be designed for minimum maintenance. Maintenance activity required shall be capable of being performed without affecting the train service.

(c) Maintenance activities shall be classified into two areas, routine preventive and corrective, both of which affect service availability.

(d) The SCADA equipment shall be selected from a common palette of materials to ensure that equipment/ cards are interchangeable between sites, spares and training on multiple systems is kept to a minimum.

(e) To optimize speedy corrective attention or maintenance, techniques employing automatic diagnostics test points, and rapid repair facilities for the SCADA and traction system as a whole shall be provided. To this end, expert system algorithm to identify location of OHE faults based on auto — transformer neutral Current & voltage shall be provided to the controller.

10.8.4 Safety Requirements

(a) The contractor shall demonstrate that no safety loop is infringed due to SCADA failure. The installation design shall incorporate measures to avoid presenting safety hazards to people.

(b) The Systems design shall incorporate measures to provide for its safe management and operation. The system shall ensure that there is no inadvertent operation of any SCADA controlled equipment.

(c) The Systems shall not give rise, or be subjected to dangerous interactions within the railway or with other systems through fail safe interlocks.

(d) The design of the earthing system shall conform to EN 50122-1. The system shall have fail-safe features. The Contractor shall incorporate the SCADA earthing design requirements in the earthing and bonding management plan and design as described in this Particular Specification.

10.8.5 Safety Targets

(a) The Contractor shall demonstrate that the systems have been designed to minimize the risk due to operator and maintainer error, considering both the ergonomic aspects of the System design to reduce the likelihood of error, and protective measures adopted to mitigate the consequence of such error.

(b) The Contractor shall show that the systems can be operated and maintainedsafely. The Contractor shall prepare a quantified risk assessment (QRA) to model the risk to (a) public; (b) maintenance and operations staff; (c) public and staff, on the adjacent Indian Railways line. The QRA may be based on a comparison of System features and operating practices with other high current main line railways and heavy haul railway systems for which risk levels are known. Accidental charging of dead section due to problem with SCADA or wrong indication causing issue of permit to work on charged section posing safety hazard shall also be prevented.

(c) Following types of interlocks shall be possible:

(i) Interlock between any numbers of items of equipment through OCC such as N-1 interlock.

(ii) Interlock locally within equipment reporting to single RTU. This shall be possible without intervention of OCC server.

(iii) Interlock between equipment reporting to different RTU's on same LAN/TCP/IP connectivity. This shall be possible without intervention of OCC server.

10.8.6 Specific Safety Requirements

(a) In addition to the safety rules which shall apply for the entire system, the operation and maintenance of equipment inside the TSS, SSP, SP and SS shall satisfy the safety rules and system operation requirements of state power companies.

(b) The system shall comply with all the relevant safety documentation, including, but not limited to 'Project Safety Manual' and any update thereof.

10.9 FUNCTIONAL REQUIREMENTS

10.9.1 General

(1) Functional requirement for SCADA equipment in the OCC and at the fields' level are being specified hereunder. The Contractor shall design, manufacture, install and commission the SCADA equipment to provide a safe, efficient and effective means of monitoring and /or controlling the connected equipment as required for the operations of the project.

(2) The SCADA system shall comprise of three basic elements:

(a) Interface with SCADA workstations and SCADA maintenance terminals for displaying the status of connected equipment to operators and providing control facilities for operators for connected equipment;

(b) Data communication links with the connected equipment to be controlled and / or monitored within the Project including use of the Data Transmission System provided by the contractor and necessary interface with Contractor SYS-2 for OFC cable communication link shall be done by Contractor SYS-1.

(c) Processing the information that allows:

(i) The information received from the connected equipment to be displayed in a consistent format.

(ii) The controls entered by operators to be converted into a form that shall be understood and correctly acted upon by the connected equipment.

(iii) The storage of all controls, events, alarms and measurands of current & voltage readings including transients to facilitate analysis of data and system behavior, including trend.

(3) The SCADA system shall have levels of redundancy in its equipment and configuration as necessary to meet the System Performance requirements.

(4) As a minimum, the central servers shall have dual redundancy with one set of servers located at the OCC equipment room interconnected with multiple redundant and spatially diverse data communication links.

(5) Multiple, redundant configurations shall be used where necessary to ensure adequate operational safety and availability for all the SCADA equipment, SCADA System interconnections and SCADA interfaces to equipment to be controlled and /or monitored.

(6) Redundancy shall be achieved either with hot standby equipment where only one unit is in use at a location or by utilizing several functionally identical units with an overall capacity such that one of the units may be taken out of use without loss of any functionality.

(7) The SCADA System shall have a distributed architecture with the majority of I/O being transmitted via high speed data communication links.

(8) The SCADA system architecture shall be arranged to minimize the requirement for marshaling large quantities and long lengths of metallic control cable to data collection points.

(9) Primary control and monitoring of connected systems shall be from the SCADA workstations in the central control room combined with playback functionality.

(10) Additionally, the SCADA system shall include a data link to a maintenance management system (MMS. This link shall enable the SCADA System to forward fault information to the MMS from all connected equipment to identity the location and nature of faults.

(11) The mechanism of control and monitoring shall ensure that the connected equipment shall continue to function correctly and in a safe manner in the event of malfunction of parts or all of the SCADA System.

(12) Control capacity, status and alarm messages displayed at each SCADAWorkstation shall be limited / filtered according to the login privileges of the user.

(13) The SCADA System shall be configured to permit phased commissioning of the project.

(14) SCADA Software shall be able to carry out concurrent Maximum Demand (MD) calculation and initiate alarm based on the trend of MD before completion of Integration period at OCC as per pre-set values, which can be altered / set by Administrator as per the requirement. The User friendly provision shall be made in the software for the same.

(15) The SCADA system shall be designed such that no single point failure of SCADA component results in failure of OCC functionalities or of the SCADA System.

(16) The SCADA system shall through 100% redundant Controller display information on the video wall to be provided by the Contractor.

(17) The Contractor shall examine the whole scope of work and scrutinize the specified system, specification for cables and equipment and work out the ratings and capacities based upon his own designs, for approval of the Engineer.

(18) The list of "I-O" requirements giving details of event type, alarm class and event text for TSS, SP, SSP, SS and AT stations shall be submitted and approval obtained from the Engineer. Notwithstanding the Approval of the Engineer, the Contractors

shall ensure the complete functionality and minimum of 20% spare Installed I/O Cards of each type. Each installed card shall have minimum of 20 % spare I/O points. In addition the Contractor shall handover the spares as specified in relevant chapter.

(19) The SCADA system Hardware & software design shall permit making suitable changes/ modifications for / in features or adding new I/O requirements like, alarms in case of maximum demand is exceeded, generating exception reports etc.

10.9.2 Supervision Architecture

(1) The SCADA system comprises of RTU's at TSS, Switching Posts (SP, SSPs & SS) and Energy Meters at Aux. Transformer Locations for necessary field data collection and data transfer to Control Center.

(2) Optic Fiber Cable Ring shall serve as the back bone of whole data transmission network and the Servers at OCC will acquire all the information's pertaining to the RTU's over IEC 60870-5-104 protocol.

(3) TSS shall include Protection, Control, Monitoring and transmission to the Local Interface Unit (LIU) and Control Center. LIU can control the TSS after OCC permission.

(4) The RTUs at TSS, Switching Stations (SSP/SP) and SS at Station shall collect data from fault locators and transmit to Control center.

(5) Control Center

(a) Operation Control Center (OCC)

The OCC SCADA equipment shall be organized in OCC Theatre and various rooms designated for SCADA purpose.

(b) Local Interface Unit (LIU) in TSS

The Traction Sub-Station (TSS) shall be provided with RTU capable of communicating with Bay Controller Units (BCU) or Intelligent Electronic Device (IED) over IEC 61850 protocols and shall be further integrated with SCADA system in OCC over IEC 60870-5-104 protocol via redundant Gateway. The gateway shall have redundant communication ports for simultaneously reporting to two masters.

The workstation in TSS shall serve as Local User Interface (LUI) for use of local operator.

(6) Conceptual SCADA system configuration for Prithla – New Harsana Kalan section is as follows attached in drawing in Part 2, Section VII-3.

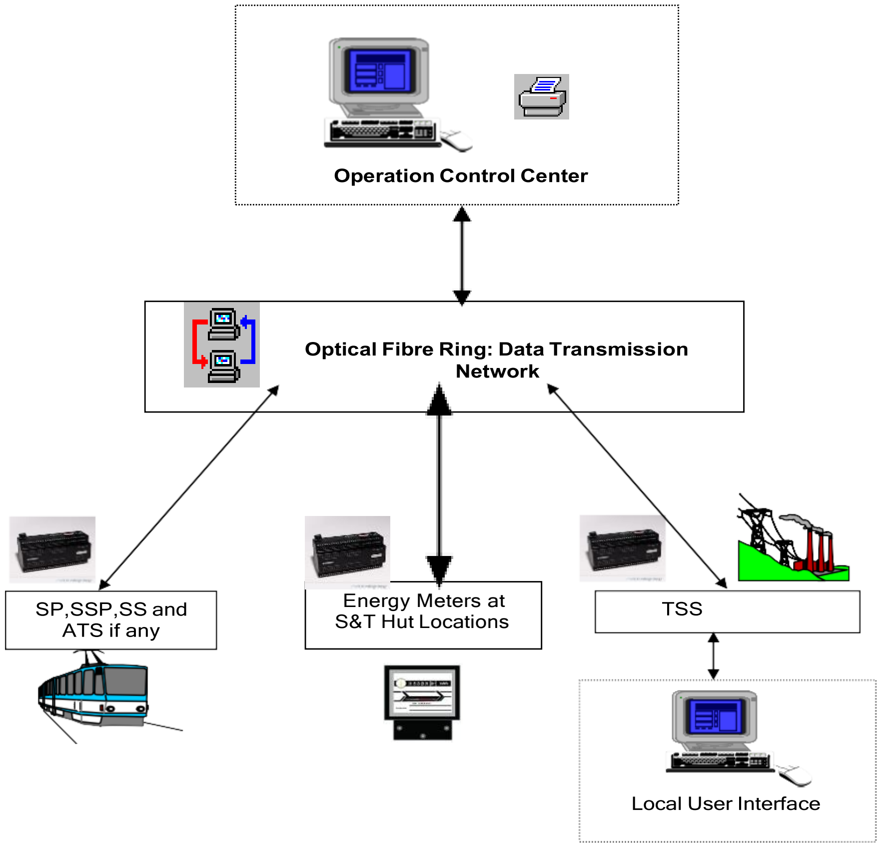


Figure 10.5.0-1 Typical Arrangement of SCADA System for SYS-1 of HORC

(1) The SCADA system shall comprise, without limitation to the following:

a) Operation Control Center (OCC);

b) Field equipment for Control and Monitoring at Power Supply Installation;

c) Data Communication Network

10.9.3 Control Strategy And Authorization Management

(1) In addition to above said control possibility, control of power supply equipment shall also be possible from local control panel of equipment, which shall ensure that the traction power supply installation and its protection system shall continue to operate in the event of failure of SCADA system. The following levels of controlsshould be possible from SCADA system of HORC.

(a) Centralized Control

(b) Local control mode from TSS for local equipment only: Operation Control Center has to grant "Permission for Local Operation" and all such authorization by Traction Power Controller shall be recorded in event list by SCADA system.

(c) Local mode from the equipment: It shall be possible to operate the equipment locally from the control panels by selecting the local / remote selector switch in the Control Panel/equipment. This selection shall be logged in the event list by SCADA system.

(d) Such control shall be only possible after taking "Permission for Local

Operation" from the Traction Power Operator. This shall be also logged in event list by SCADA system.

(2) A control transfer mechanism shall be developed based on above principle and confirming to operation requirement of HORC and implemented in SCADA system at various control points (Central, Local, Equipment etc.)

10.10 Remote Terminal Unit

(1) General

General requirement for fields' level equipment viz RTU, under provision of SYS-1 Contractor's scope of work shall as minimum, compliance with the following;

(a) Remote Terminal Unit (RTU) shall be installed at all TSS, SP, SSP, and SS. It serves as interface between switching stations (All TSS, SP, SSP and SS) and master station (OCC); RTU for SP and SSP shall be interchangeable.

(b) RTU shall be able to perform both data acquisition and local data processing. In the case of a communication path failure, the RTU shall operate as an independent intelligent unit and acquire and store data without interruption. On resumption of normal communication, the data shall be transmitted to the SCADA system;

(c) The RTU shall support remote programming facility using RTU programming utility software from the master control Centre. A port on the RTU shall be dedicated to the master control Centre via one separate non redundant Ethernet communication channel;

(d) The RTU shall be capable of communicating over IEC60870-5-104 with Control Center, IEC 61850 for interface with Relays, BCU, IEDs; IEC 60870-5-103 for interface with protection equipment; Modbus protocol for communication with Energy and Multifunction meters on Ethernet communication with Intruder Detection system and Access Control System.

(e) In case of failure of communication between control posts and OCC/BCC, the local protective relays shall continue to function with all their protective features, including the lock out features on a persistent fault. All information in regard to the occurrence including data shall be stored in the RTU end for up to at least 1000 events and shall be transmitted the OCC on resumption of normalcy.

(f) RTU shall continue to operate all safety features during failure of SCADA channel to OCC.

(g) The RTU shall be capable to handle analogue input, digital input, and control output signals.

(h) For each traction power supply Control post, the RTU shall be equipped to handle all the I/O points as required. In addition, the RTU shall include fully configured spare I/O points (Minimum 20% in each type of card) available for the Employer's use; The RTU for a TSS without any standby traction transformer should allow addition of standby traction transformer and associated equipment.

(i) The RTU shall have an internal clock for data collecting coordination and time tagging. The internal clock shall be completely independent of the synchronization source so that the RTU shall continue to properly handle its time related application in case of source and communication failure.

(j) RTU shall support maximum demand (apparent power) calculation based on 5 to 30 minutes window periods based on inputs received from energy/power transducers similar to that of Power Utilities matched with time clock. The value of Maximum Demand (MD) shall be reported to OCC after each window period;

(k) It shall be possible to reset the CPU of RTU from OCC in case it hangs due to any reason;

(l) High-resolution sequence-of-events (SOE) processing and reporting capability shall be as follows;

(i) Detect changes in the state of SOE points;

(ii) Record the date and time of change with a resolution of $\pm$1 ms;

(iii) Ability to retransmit stored SOE data if requested by the systemMaster Station in order to ensure that SOE data are neither lost nor overwritten until the RTU acknowledges the receipt of the data. A buffer capable of storing at least 1024 events shall be provided;

(m) Ability to communicate with the local user interface (LUI) for control & Monitoring / maintenance purposes in case of communication link failurewith OCC;

(n) It shall be possible to increase the number of communication ports in the RTU by addition of suitable cards, if required in future;

(o) It shall be possible to mount the IO modules and the processor/ communication modules in the same rack of RTU.

(p) RTU software shall be capable of being reconfigured (under password control) locally from the laptop/portable programming device and from the central master station by using IP based RTU maintenance software. Contractor shall furnish authentic copies of RTU software in Hard Disc Drive (HDD);

(q) The RTU shall have self-monitoring/diagnostic for fault conditions. This shall provide various details such as status of ROM, data bus, RAM check, battery low, defective cards etc. The RTU should generally support the test procedures as per standard protocol IEC 60870-5-101 & 104;

(r) The RTU address shall be configurable. The RTU address shall not be lost in case of power swings or surges. It shall be possible for the Employers' Staff to reconfigure the address for the remote station.

(s) In case additional RTUs are to be configured, configuration manual shall be provided by the Contractor and the Employer's Staff should be trained to configure additional RTUs as and when required.

(2) RTU Cabinets

(a) The RTU installations shall be dust, rodent and vermin proof with doors. The doors shall have proper rubber gaskets & locking arrangement. The cabinets shall have facility for bottom/top entry of incoming/outgoing cables for operation of the equipment. The Cabinet shall be manufactured from CRCA sheet of Minimum Thickness of 1.6mm (with Door of minimum thickness of

2.0mm), Passivized, cured and acceptable quality treatment, powder coated (with 7 tank processes) so as to make the surfaces rust and scratchproof quality. Suitable reinforcements shall be provided wherever necessary.

(b) The RTU shall be floor mounted. The Contractor shall offer as small cabinet as possible without compromising on maintainability and serviceability of the RTU equipment. There shall preferably be only one RTU cabinet housing all equipment. All RTU enclosures located indoor shall conform to minimum Ingress protection class IP 54 as per IEC 60529. All enclosures located outdoor/ open/under shade shall conform to minimum Ingress protection class IP 65 as per IEC 60529. The interior of the panel shall be lit on opening, using a CFL/LED lamp by a door controlled switch.

(c) Modular type of construction shall be adopted to facilitate unit replacement of devices wherever required. Surface mounted technology or better (SMT) shall be used for higher level of reliability. Standard plug-in and connector arrangement shall be made for the printed cards.

(3) RTU Wiring

(a) All internal RTU control circuits and wiring of DI/DO & other signal circuits between Control and Relay (C & R) panel and RTU shall be with at least 0.75 sq mm, 1100 VAC / 1500V DC grade PVC insulated copper conductors conforming to IS 694.

(b) RTU shall be wired with 1.5 sq mm XLPE insulated copper conductors conforming to IS 7098, 1100V ac/ 1500Vdc grade (screened wherever necessary) only for main incoming 110Vdc & 240 V ac power supply (4 sq mm copper only for CT wiring).

(c) Harnesses of wires/cables shall be neatly dressed, laid in metallic and supported suitably. Separate wire bunches shall be run for ac, dc, control and data circuits. Caution plates and name labels shall be provided inkeeping with good engineering practice.

(4) RTU Software

(a) The term "RTU software" used in this Particular Specification means software used at RTU generally implemented through firmware. All Softwareshall be implemented according to the Contractor's established design and coding standards. Complete and comprehensive documentation shall be provided for all software to the extent that it is used in any way to configure or manage the system.

(b) The RTU software shall provide automatic restart of the RTU upon power restoration, memory parity errors, hardware failures, and manual request. It shall initialize the RTU and begin execution of the RTU functions without intervention by the OCC. All restarts shall be reported to the system Master Station.

(c) In order to provide for easy upgrading and/or correction, the RTU software shall be stored on a removable flash memory card. In addition, it is required for the RTU to perform the following tasks remotely:

(d) RTU software and database maintenance;

(e) RTU diagnostics;

(f) Configuration of RTU parameters and programmable logic functions;

(g) The RTU software shall also support an easy, user-friendly human interface enabling an authorized operator to perform local supervision, control and/or maintenance of the RTU. There shall be a context sensitive interactive help window, e.g., a pop up text window displaying relevant help information.

(h) The System Functions to be supported by the RTU Software shall be as follows:

(a) Equipment control;

(ii) Equipment indications;

(iii) Equipment alarm and event handling facilities;

(iv) System configuration and database maintenance;

(v) Manual and automatic control function configuration;

(vi) Protocol management;

(vii) Measurement values and computations;

(viii) Automatic self-diagnostic;

(ix) Help information;

(x) Archiving.

(5) Local User Interface (LUI), Only for TSS RTU's

(a) The RTU shall support a LUI for use by the Employer's staff and shall allow local operation.

(b) As a minimum, the LUI shall perform the following functions:

(i) View remote station data and alarm information on graphical and tabular displays. This function shall include one-line diagram displays of the associated substation for viewing dynamically updating data and alarms.

(ii) Initiate control actions, such as opening and closing circuit breakers, interrupters etc. This function shall operate on a Select-Check-back-Before-Operate (SCBO) basis, and shall include appropriate security to prevent inadvertent and unauthorized control actions.

(iii) Store historical information such as alarms, events and analog measurement. Maintain LUI and RTU software, database, and displays.

(iv) Execute LUI and RTU diagnostic programs. The diagnostic programs are installed in the RTU-Software, thus no special installation shall be necessary on the computers/laptops used to present the LUI.

(v) Configure RTU system parameters.

(vi) Configure RTU programmable logic functions.

(6) RTU Environment Conditions:

(a) RTUs shall be subjected to severe temperature variations and vibration conditions produced by moving rolling stock. The amplitude of these vibrations is expected to be in the range of 30 to 150 microns, with rapidly varying time periods in the range of 15 to 70 ms and occasional peaks of 350 microns.

(b) The track side cubicles shall not be air-conditioned and are liable for exposure to polluted, dusty and corrosive atmosphere. The environmental conditions are given in clause 4.2 of this PS. The RTU hardware shall be immune to electromagnetic interference from nearby high current electrical equipment, to ensure safe and reliable operation under all loads and faults. Electromagnetic compatibility (EMC) shall meet the requirements of relevant international standards.

(7) Protection against Surges

(a) The power supply unit/DC-DC converter of RTU shall have internal protections against under voltage, over voltage, overload and short circuits in addition to adequate protection against surges and lightning in compliance of IEC-61643-12, 61312 & 61024 and DIN VDE-0100-534, as applicable.

(b) In signaling line surge protection device of class D type shall be provided as per IEC 61643-21 & DIN VDE 0675 Pt. 6.

(8) Earths / Earth stations

(a) Contractor shall provide a separate maintenance free low resistance (<1 ohm) Clean earth station for RTUs and SCADA Equipment. The RTU body/frame shall be suitably connected to the separate earth.

(b) Overall responsibility to ensure suitable design of RTU earthing arrangement to avoid failures of electronic cards etc. in RTU shall be that of the Contractor.

(9) Electrical Protection for Power Supply

The Contractor shall ensure proper electrical protection by providing MCBs. There shall be one MCB per supply circuit.

(10) Redundancy

(a) The Power supply cards for the RTU system shall work in (1+1) hot standby mode. Failure of one supply card and its switchover to the standby card shall not cause any interruption to the functioning of SCADA. All failures shall be recorded as an event and stamped with date and time.

(b) The RTU shall communicate with the Master SCADA server through redundant communication channels. The RTU communication cards and the server shall be, accordingly, configured. Redundant data channel of adequate bandwidth shall be provided by the contractor.

(c) Processing Cards for the RTU shall be provided in (1+1) hot standby mode. Switchover from main to standby, card shall be transparent to the system functioning i.e. there will be no loss of function during the changeover period.

(11) PLC Programming Facility:

To enable programming for logic functions as required for the traction powersupply distribution application, the RTUs shall support PLC in compliance with IEC 61131-3. The required programming tool shall be within the scope of the work.

(12) Time Synchronization in RTU

The RTUs shall be time synchronized with the master Clock. Further the RTU shall support the following methods of synchronization:

(a) Time synchronization of the RTU by the network control Centre (NCC) via a periodically transmitted synchronization instruction with a communication protocol supporting this function.

(b) Time synchronization of the RTU using SNTP on a LAN network

(13) Cyber security Features

RTU shall be capable of User activity logging and role based account management with password complexities based on at least one character options.

(14) Central Processing and communication unit:

The Central processing unit shall employ at least a 32 bit microprocessor and a dedicated peripheral bus controller for handling IO functions and adequate RAM - flash memory and high processing power. Features shall be identical in the redundant CPU. The CPU module shall have nonvolatile memory. The CPU module shall support the following Ethernet and serial port requirements in one or more CPU modules;

(a) It shall have necessary communication ports for communication with at least 2 control centers i.e. one main control Centre and one back up control Centre on IEC 870-5-104 protocol. Also the RTU shall be capable of communication with maximum of 8 masters.

(b) It shall support data acquisition from energy meters.

(c) The Central RTU shall include minimum of 4 serial ports using RS232/ RS485 interface and 2 Ethernet ports to communicate with IEDs by using the IEC61850/IEC60870-5-103/DNP 3.0 protocol. The Ethernet ports in the communication modules shall be of 100 Mbps.

(d) The RTU shall have one MMI port which may also be used for configuration purpose.

(15) Analog Input

(a) The analogue inputs module shall have minimum 8 channels per module and shall support dual slope integration A/D conversion.

(b) The RTU analogue-to-digital (A/D) converters shall have a digital resolution of at least 11 bits plus sign.

(c) The analogue module shall support the following signal :

(i) Unipolar Measured Values

(ii) Bipolar Measured values

(d) It shall be configured for the following measurement ranges:

(i) 0 - 2.5 mA

(ii) 0 - 5.0 mA

(iii) 0 - 10 mA

(iv) 0 - 20 mA

(v) 4 - 20 mA

(vi) 0 - 1.0V DC

(vii) 0 - 10 V DC

The accuracy shall be better than ± 0.1% on full scale.

(e) Following Programmable parameters shall be supported:

(i) Live zero conversion coefficient Cyclic;

(ii) Transmission or threshold value Forced;

(iii) zero point conversion coefficient Limit;

(iv) Values Smoothing factor Threshold;

(v) Values Cyclic duration;

(vi) Priority of transmission.

(f) Other parameters:

(i) Inputs shall be configurable for 4 to 20 mA / bipolar or live zero

(ii) Accuracy- </= 0.25 %

(iii) Common Mode Voltage : +/- 8 V DC

(iv) Line Interference suppression : > 100 d for f =50 Hz

(16) Transducers:

(a) The independent transducers converter/ multi-function transducers (MFT) required for acquiring Analogue inputs from CT/PT shall be supplied by the Contractor.

(b) The transducers shall be selected for nominal 110 V ac (Ph-Ground voltage) and 1A/5A CT/PT inputs. The transducers shall withstand input voltages up to 120% of the nominal voltage and shall be suitable for 20% continuous over load and 20 times the normal current rating for a period of one second.

(c) Transducers shall provide at least the following parameters as a minimum with the specified accuracies.

Sl. No.	Parameters	Accuracy
(I)	Voltage (Each phase to neutral and phase to phase)	±0.5%
(ii)	Current (each phase)	±0.5%
(iii)	Active Power, Reactive power, Apparent Power	±0.5% / ±1%
(iv)	Import & Export Energy (active/reactive)	±1% / ±2%
(v)	Power Factor (measuring range)	0.5 lag to 0.5 lead
(vi)	Auxiliary Power supply	

(d) Temperature and pressure monitoring transducers shall be similarly rated and provided with the independent power supply drawn from local LT supply.

(17) Digital Input Module:

(a) The Digital input module shall have at least 16 optically isolated channels per module and shall support time stamping with time resolution of 1 Ms.The digital input module shall support configuration of inputs for the following options:

(i) Single Indications

(ii) Double Indications

(iii) Digital Measurands

(b) The digital input module shall also support the programmable parameters including but not limited to:

(i) Bounce Filter (Suppression Time);

(ii) Settling time for reliable digital measured value;

(iii) Chatter suppression;

(iv) Suppression of intermediate position;

(v) With / without time tagging shall be a configurable feature;

(vi) Configurability of message transmission priority.

(vii) Indication processing

(c) Group or Common alarms shall be configurable from Individual alarms by Boolean operations;

(d) Acquisition of events in chronological order with a time resolution of 1 ms - Buffering up to 3 changes per input.

(18) Digital Output

(a) The Digital Output module shall support at least 16 digital output channels per module. The output module shall support time stamping with time resolution of 1ms and shall support following Programmable Parameters which shall include:

(i) Duration of output pulse

(ii) Release disconnection delay time at response indications

(iii) Select before execute

(iv) Cyclic duration

(v) Priority of transmission

(b) Interposing contactors/relays for operating the closing and tripping circuits shall form part of the SCADA equipment. The contactors/relays shall be suitable for 110 V dc supply varying from + 10 % to -20 %. The contacts of relays shall have a continuous current carrying capacity of 5 A, making capacity of minimum 10 A and breaking capacity of 2 A inductive load. Suitable spark quenching circuit shall be provided to take care of breaking inductive loads.

10.11 SCADA SOFTWARE

10.11.1 The basic requirement of SCADA software for the HORC Section, as minimum shall be as under:

10.11.2 General Requirement

(1) The software shall be compatible for working on IEC 60870-5-104 companion standard protocol based on IEC 60870-5-1 to 5 series of standards. It shall also support multiple channels for communication to all RTUs as per TCP/IP based IEC60870-5-104 communication protocol;

(2) The software shall fully support data transfers between RTU & OCC as defined by different IEC 60870-5-104 series of standards;

(3) The software shall give fast response to operator actions and system events. SCADA system stability should be sustained during event bursts. The software should be capable to support system working at high speed data transfer rates achievable over OFC communication networks;

(4) Software/system performance shall not degrade or drift due to generation of temporary files etc. which the software shall clean/delete automatically;

(5) Only the valid licensed copies (CD/DVD or in HDD as decided by Engineers) of complete SCADA application, commercial and peripheral software shall be supplied. The firewall /antivirus software provides shall be valid up to the Defect Notification Period (including extended DNP, if any);

(6) SCADA vendor shall provide all necessary run time utilities for successful running of the SCADA application. The utilities supplied by the Contractor along with operating system should be sufficient to independently execute the SCADA software without any problem.

10.11.3 Functional Details Of Master Station Software

(1) Acquisition of measurands

(a) The SCADA system shall be capable of acquiring measurands i.e. analogue inputs from the TSS, SSP, SP and SS including transient values. The measurand data shall be real time stamped/tagged at field level RTU.

(b) Software shall have capability for Analogue value scaling, processing and conversion to engineering values, limit settings of parameters centrally from OCC or from any Point/ RTU.

(c) Software shall be fully configurable to analyze the analogue data received from RTU e.g. energy parameters (active, reactive and apparent power & energy), voltage, current and power factor in the form of displays (graphs as well as tabular), trends, alarms to operator in case of set limit violations and historical interpretations.

(d) Software shall also be able to analyze the transient analogue data for detection of faults and their corrective measures.

(e) There shall be facility to transfer the data to spreadsheet applications like MS-Excel in .xml formats with User friendly Utility Program.

(2) Acquisition of Tele-signals

(a) The software shall support the acquisition of tele-signal (bi-state devices) for each RTU.

(b) There shall be dependent and independent points in the traction power supply system. For example, if a feeder Circuit Breaker Trips, there shall be associated tele-signals for catenary and 240 V AC fail. All such events shall be reported by RTU to OCC with time stamp.

(3) Execution of Tele-commands

(a) The Software shall be capable of issuing tele-commands to open or close a switching device. All the commands shall follow select — check — execute and report back execution procedure.

(b) The Tele-commands shall receive the highest priority in conformance to IEC 60870-5-104.

(c) Operator shall be able to cut off power to a sub-sector by selecting it and giving the command. The system shall open all the associated switching devices automatically in appropriate order with confirmation for each device as an event.

(d) Option to abort a command shall be available with the operator till it has not been acknowledged for execution at the switching stations. Any command which does not get executed within the specified time as per design, shall be automatically cancelled and confirmation to this effect communicated to operator.

(e) All the operator commands shall be logged as events. After a control command is issued by the operator, and if the command is not executed, then a message shall be displayed indicating reason(s) for it.

(f) The Tele-command once selected, if not sent to RTU due to communication failure or otherwise, shall be aborted after a predefined period of one (1) Second and shall not remain in queue and reported to operator.

(4) Parameter loading to RTU

(a) The OCC software shall be capable of parameter loading to the RTU in line with IEC 60870-5-104 & other basic standards of IEC 60870-5-104 series. Some configurable parameters are as under:

(i) Dead band for RBE (Report by Exception) of an Analogue value.

(ii) Pulse duration of control commands.

(iii) Used point of each type in an RTU. (Number of point used of a particular type of point)

(iv) Event reporting details which include windows time and de-bouncing time.

(b) The de-bouncing time, dead band for measurands and the clock synchronization time period shall be settable and so selected that the optimum use of data communication channel is made.

(5) SCADA software configuration

The software shall provide menu driven and user-friendly configuration. The configuration shall define the various devices, their attributes and the tractionsystem specific details. The configuration of the software shall be carried out to cover all details/address/nodes of traction supply operation e.g. Interlocking, locked out signals, protection relays & elements, alarms with attributes, power blocks, parameter settings and display/picture screen properties etc.

(6) Time Synchronization

The master clock installed in OCC shall be used to synchronize the Host Computer clock and the clocks of the RTUs.

(7) Test Procedure & Diagnostics

(a) The software shall support basic test procedure and diagnostic checks for RTU as per IEC 60870-5-104 & basic standards of IEC 60870-5 series. As in IEC 60870-5-104, there is no periodic polling for Class1/Class2 event from the master and all events shall be reported by exception from the RTU. The only periodic poll from the master shall be the general interrogation, at intervals not exceeding 10 minutes. Apart from this, master shall send a TESTER packet 10-15 seconds, to check the health of the RTU and communication media.

(b) SCADA application software shall have minimum following inherent features to check its own sub functions and report status to the operator:

(i) Online/standby /offline state of SCADA server/communication front ends.

(ii) State of all RTUs.

(iii) State of printers.

(iv) Connection status of all the operator workstation.

(v) Diagnostics shall use standard OS tools to be provided as part of the administrator tools.

(8) **Communication Failures**

Time out of the RTU and the cyclic redundancy check (CRC) errors shall be progressively counted and displayed in a tabular report as "Communication failures" for each RTU. The tabular report shall be generated at 4.00 hrs., Every day for the preceding calendar day of 24 hours.

(9) **System security and access levels**

(a) The system shall provide three security levels for access for different functions:

(i) Traction Power Controller (TPC): - To view and Control;

(ii) OCC Engineer – To edit configuration information;

(iii) System (Admin)/ Engineer- Able to do everything.

(b) The Contractor shall liaise with the Engineer as to which facilities each security level is given. This shall be undertaken in coordination with the Engineer developing the Control Room rule book.

(c) There shall be no remote/email/internet access, user access codes/passwords in the master station software and hardware so that any possibility of a cyber-intrusion or attacks is eliminated. Reasonable precaution, by way of installing fire-wall, and blocking ports for connecting external devices like pen drives, CD drives etc. shall be ensured. This will also be applicable for preventing the access, to manufacturer after the SCADA is handed over to Employer or access to any employee who has left the job.

(d) There shall be means to indicate & give alarm in case an intrusion event occurs either through a connection or a peripheral device.

(e) In addition backup and recovery procedures for the SCADA system shall be well defined by the Contractor. The Contractor shall train the Employer's staff on the security threats and vulnerabilities involved with IP based systems.

(f) The Contractor shall provide in OCC, a workstation with a general purpose computer for non SCADA applications. e.g. internet browsing and word processing. The general purpose computer will be connected to the general office LAN and NOT to the SCADA LANs. The computer shall be of latest version with at least 2 TB HDD and 256 GB RAM along with UPS.

(g) **System Users and User Authentication** :

User Access to all functions of system shall follow a consistent set of common user access guidelines. The user access to system, database, and operating systems shall be based on password authentication. Defining and controlling user access to the system shall be provided through independent domain server. The domain server shall be in redundant configurations. A user management application shall be deployed to manage and to help achieve seamless access to all applications after identity authentication of the users.

(10) **Status Information**

The SCADA system shall be able to display status information for switching station equipment such as device name and its current value/status, scans status (on/off scan), override status and block status shall be displayed.

(11) Breaker Operation Counter

The system shall monitor operation counter of the circuit breakers. The operation counter shall segregate normal operations and fault tripping after analyzing the associated trip relay data. It shall generate alarms after a predefined limit of normal & fault operations is reached. If a pre-determined limit is reached then a maintenance flag shall be sent to the maintenance planning system. The operations counter data shall also be sent to the asset management system at a predetermined time each day.

(12) Block/Un-block control for devices

Facility shall be provided to block / de-block a control point (circuit breaker, interrupter and other controllable equipment or a set of controlled equipment at the controlled station). The block or unblock command shall disable/enable control operations from the OCC. The blocked condition of any equipment or a set of equipment shall be suitably indicated on the monitor.

(13) Boundary post operation:

The design shall be such that it shall be possible to provide interlocks between two control centers in future, if required to interlock any equipment or a part of section at the end of its zone of control. For example, when a post separates the zones controlled by two adjacent OCCs, control of breakers/interrupters at this post shall be so arranged that the breakers/interrupters can be closed by one OCC only when an interlock is released from the other OCC. However, opening shall be possible from any of the OCC, in such cases there shall be visual alarm indicating that the opening was initiated by another OCC.

(14) Alarm Processing and displays:

(a) Blinking Visual and audio alarms shall get generated whenever the state of device is found to be in the abnormal condition or any measurand's set limit is violated, with facility with the operator to silence the audio part of the alarm and the blinking visual alarm is changed to steady state once for every alarm generation.

(b) In the event of failure of RTU or any equipment at RCC such as Host or HMI, an equipment alarm shall appear. When both the auxiliary contacts of a device are either in open or in closed condition, such faults shall be detected and identified as "Complementary Faults". Such conditions shall be logged in alarm and event list. The alarm list shall be of two kinds — current and historic.

(i) **Current alarm list** shall contain minimum 400 entries. The list shall be ordered chronologically. Acknowledgement status of an alarm shall be indicated in the current alarm list.

(ii) **Historical alarms list** shall consist of all alarms for the last one month.

(c) Operator shall be able to request for display of the alarms in chronological order starting from any given time. Provision for sorting of historic alarms on various options such as a geographical area, station-wise, Equipment wise or tag wise, and in chronological order shall be supported. Alarm list shall be printable on user's request or downloadable in a format compatible by commercially available spreadsheet software, clearly separating original & consequent alarm such as circuit breaker trip & consequent loss of voltage.

(15) Alarm acknowledgement

(a) Page wise facility for alarm acknowledgement with a single click and confirm shall be provided in addition to one by one acknowledgement.

(b) There shall be facility to define certain alarms with audible sound or pre-recorded voice to attract the attention of the operator as per user requirement.

(c) There shall be facility for time delayed alarm operation e.g. alarm for tripped capacitor bank circuit breaker closing reminder.

(d) There shall be a facility to label a post under maintenance & to disable the audio alarm for particular post/ RTU equipment by the operator. For scenarios such as contact chattering, it shall be alarmed as a failure and; visual indication of the discrepancy shall however remain active till its resolution. The list of disabled alarms shall be reported on the daily log each day until the alarm is reinstated.

(16) Events display

(a) Events shall be logged separately for all commanded and for unusual un-commanded changes in equipment status, acknowledgement of alarms,limit violations of analogue points, successful and unsuccessful user login and markings done by operator from HMI shall be logged clearly with different heads.

(b) The event list shall be of two kinds – current and historic, same as explained above and same facilities for sorting, displaying and printing of event reports shall be available.

(c) Processed alarms: It shall be possible to create processed alarms in the system. For example, there are two events, event A and event B, which are not classified as alarms, however, if they occur both together an alarm shall be generated. It shall be possible to apply any Boolean operation or time delay to any number of events to create or process an alarm.

(d) Searching and sorting: The alarms and event lists shall be fully searchable and sort-able, in a similar fashion to commercially available spreadsheet software.

(e) Event list security: The list shall be protected by a password & authorization by the Engineer, so that it shall not be possible for any unauthorized operator or person to edit or delete the event lists.

(f) It shall be possible to view a historical view as a video on the SCADA operator screen.

(g) Events are listed in chronological Serial order of Occurrence of Events(SOE).

(17) Play Back Feature

(a) The SCADA software shall have the feature of playback of data (digital and analogue signals) from the historical database. It shall be possible to display the stored data on single line diagram. It shall be possible to configure the time window with the parameters: Start Date, End date, Time of Window, and Sampling Rate for playback.

(b) The software shall include a feature to differentiate the playback display from the normal displays.

(c) It shall be possible to generate log files from Play back feature for further Analysis.

(18) Tabular Displays

(a) Tabular displays shall be provided for the following:

(i) RTU communication Display

(ii) Abnormal summary display — This display will show the points in a station with abnormal status like - off normal status, blocked, manually entered, and not updated

(iii) Blocking Summary Display

(iv) Tag Summary Display

(v) Manual entry summary Display

(vi) Operators note summary Display

(b) From the tabular displays the operator shall be able to locate the point on a single line diagram

(c) The Tabular Display shall support the following features

(i) On line configurable

(ii) Multiple data Entry

(iii) Sort one or more columns

(iv) Filter

(v) Sort a filtered list of filter a sorted list

(vi) Resizing of columns

(vii) Print out the display

(19) Power Block Identification

(a) Power block for maintenance or inspection shall be granted by the operator / controller in the OCC in pursuance of an approved written down procedure that enables identification of all the authorized and trained personnel granting the block i.e. (the controller of the authorized person requesting the block through a system of passwords & interlocks) and the recipients of the permit to work and precautions to be observed. The Power block shall not be able to be cancelled & section energized unless the permit has been returned by the recipients and the block is cancelled by the person who was granted the block. In case a tele-command is attempted, for energizing the device/ section under block, the command shall be aborted and a hazard message at the OCC and the RTU shall get generated.

(b) Granting the power block: The software shall have facility to select the device/section to be brought under power block and kept under power block or to be taken out of power block.

(c) It shall be possible to select a number of circuit breakers / Interrupters required to be operated for making a section dead and a group command shall be possible to be issued. The system shall be able to open all devices of the sections, which are put under power block by the operator. The closing operation shall be confirmed for each device as an event. The operator shall be able to modify/create such predefined sequences and save. Such operator created programs shall be available only to the creator and not to the other operators. There shall be a function to allow the system engineer to copy user created programs for other operators.

(d) Operator shall be able to cut off power to a sub-sector by selecting it and giving and confirming the command. The system shall open all the associated switching devices automatically with confirmation for each device as an event.

(e) The operator shall have to enter the details of the power block like the operator's code number, and time duration of power block. All power block details like operator's identity, time of imposition and section shall be recorded along with system time.

(20) Cancelling the power block

(a) Only on authorization of the field supervisor having been granted power block, the operator shall be able to select the device or the section on which the block has to be cancelled and give power block cancellation command. With this the power block of the devices/section shall be removed.

(b) If a power block is not cancelled at the end of the permitted duration, a suitable alarm shall be generated to attract the attention of the operator. System shall not permit the operator to charge until cancellation of the power block.

(c) It shall be possible to display or print the information of all power block details giving clear details regarding operator's identity, time of imposition and its cancellation. Power block details shall be stored in the database for later use and the switching events.

(21) Under-voltage tripping of SP Bridging Circuit Breakers

Under extended feed conditions, if a low voltage at SP persists for more than a specified time (both of these shall be configurable), an alarm shall be sent to the operator. If the voltage continues to be in the low range even after this time (i.e. operator has not taken any action within specified time to restore normalcy) then the bridging device shall be opened by the concerned RTU through close loop action on voltage limit violation and shall be implemented using ladder logic or IEC 61131-2 control logic. Any override operation shall be possible only through authentication by an administrative head nominated for the purpose.

(22) Data logging and Reports generation

(a) All alarms and events shall be logged by the system. Average, minimum and maximum values of selected analog parameters shall be stored. The duration of this logging shall be settable and logged data shall be stored automatically with date (year, month and day) and time (hours and minutes) stamp in a file. The software shall be capable of generating different types of reports.

(b) Some of the reports which may be required are: -

(i) Summary of circuit breaker's tripping during a specified period including the relay(s) which caused the tripping;

(ii) Power block availed report;

(iii) Event and their durations during the month when the voltage went beyond permissible levels at the TSS and SP respectively & parameters of excesses;

(iv) Duration during the month when the current exceeded nominal full load capacity of the transformer;

(v) Energy data interpretation, Maximum Demand violation;

(vi) Morning reports of all the abnormal incidences in the last 24 hours.

(23) Tabular displays, Current & Historical trends diagrams/ graphs:

(a) The software shall be capable of providing tabular display of data of a controlled station e.g. equipment status, alarms and measurands.

(b) The time versus value plot of measurands in a separate colour including the arithmetic values on the measurands such as multiplication shall be displayed in a trend diagram. The trending shall include both historicaltrending and dynamic trending of current data.

(c) The dynamic (current values) trending shall be for duration of one hour. For historical trend, average value of data shall be logged at the interval of 5 min duration.

(d) It shall be possible to permit the dynamic values in the forms of graphs to an accuracy of 5%.

(e) It shall be possible to store historical data of 5 years. If required a separate server may be provided at back end to store historical data.

(f) However, all data shall be accessible from the main screen where operator normally watch the recent data.

(24) Database creation

(a) Database creation for the complete system shall be possible through Microsoft Excel based tools or similar. Small addition and deletions of I/O points shall be possible online with minimal disturbance to the Operators.

(b) Complete system restarts shall not be required for such minor operations.

(25) Bus Bar Coloring:

(a) The SCADA software proposed shall support necessary bus bar colouring feature by which the dynamic status of the bus bar can be depicted during charged and dead (discharged) conditions.

(b) Earthed equipment, blocked equipment, faulty equipment, faulty status, communication failures shall be displayed in separate colours.

(c) The coloring shall be provided on all screens (overview / individual or sub-picture) at all times.

(d) The status change shall be reflected through colour change within 2 seconds on the display.

(e) It shall be possible to give a specific colour to any section based on an intelligent rule.

(26) Application Programming Interfaces (APIs)

(a) Since other applications for which interfaces with SCADA data may not have been defined at time of tendering (e.g. Fault Call Management etc.) The SCADA, system shall provide open APIs that can be configured at a later date to suit future interface requirements.

(i) Objective Data Base Controller (ODBC) support for data interchange between MS-Windows clients like Excel and the real-time/historical databases.

(ii) A generic library of services for database access and activation of SCADA procedures and services from external applications.

(iii) Support of all APIs in heterogeneous computer environments and to be network transparent.

(b) A wide range of remote terminal communication protocols for interfacing RTUs and substation control systems from different vendors.

(27) Integrated Graphical & Data Engineering Tool

The integrated graphical & data engineering tool shall provide, as a minimum, following functions:

(a) Automatic linking of station and network pictures with the SCADA data as part of the data engineering function;

(b) Support for mass data entry through copy and paste, or excel export import.

(c) Incremental loading of real-time database.

(d) Rapid switch over to new database without data loss. Drag and drop support for linking to data base and pictures.

10.12 NETWORK MANAGEMENT SYSTEM

The provision for Network Management at OCC, shall executed under the scope of Contractor (SYS-1) for the entire Section. The Network requirement and features are being characterized hereunder.

(a) Network management system to facilitate following activities:

(i) Security Management to protect system and network from unauthorized access, manage user access, authorizing privileges.

(ii) Inventory Management to collect information such as processors, memory, peripherals and processes running of computers/any processor based equipment in SCADA system.

(iii) Performance Management to monitor system and network performance as specified.

(iv) Fault Management to recognize, isolate, log and identify fault on network and connected machines, nodes, devices.

(b) The NMS system shall have a simple browser based user interface toprovide all the pertinent information about the system. The NMS shall not impact the availability and performance of SCADA.

(c) The Network management system shall monitor the performance, resource usages and error statistics of all the servers, workstations, routers and switches including the following:

1. Utilization (CPU and/or channel time being used as applicable) for

   (i) Servers, Workstations, Storage Devices

   (ii) LAN, Router, Switches, Firewall

   (iii) Data Links

2. Memory utilization, Auxiliary memory I/O utilization of

   (i) Servers and Other Machines

   (ii) Mass Storage Devices

(d) The Network Management Software shall :

(i) Maintain performance, resource usage & error statistics and present this information via displays, periodic reports, and on demand reports. Apart from real-time monitoring, the above information shall be collected and stored at user configurable periodicities i.e. 5 minutes to 60 minutes.

(ii) Maintain a graphical display for connectivity and status of servers and peripheral devices for local area network.

(iii) Issue alarms when error conditions or resource usage problems occur.

(iv) The period over which the statistics are gathered shall be adjustable by the user, and the accumulated statistics shall be reset at the start of each period.

(v) The statistics shall be available for printout and display after each period and on demand during the period.

(vi) The user interface provision shall be made in OCC.

10.13 TESTING, COMMISSIONING AND VERIFICATION

10.13.1 General

(a) Tests shall be performed in accordance with Chapter 8 –Supply, Installation, Testing and Commissioning of Employer's Requirements General Specifications.

(b) The Contractor shall develop a full test plan including integrated test and commissioning and performance verification and submit for review by the Engineer at least one month before any on site tests are to be performed.

(c) On receipt of no objection from the Engineer, the onsite tests as indicated therein shall be performed by Contractor. The tests mentioned herein are indicative and minimum requirement.

(d) Test Certificates

Six sets of all principle test records and test certificates duly endorsed by the Contractor are to be submitted for the review by the Engineer in accordance with the specifications relating to the item, component or equipment. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

10.13.2 Testing of SCADA Equipment

The Scope of Work of SCADA equipment at the OCC and Field level has been specified under preceding Para 10.2 (PS) for Contractor SYS-1. However, the basicrequirement of Type test and Factory Acceptance Test, as minimum is as under:

(1) Type Tests and Factory Acceptance Tests

(a) SCADA equipment shall be offered for factory acceptance tests before dispatch. These tests shall as a minimum comprise of but not limited to the following:

(i) Communication Protocol Test: All the important services as per IEC 60870-5-104 and 61850 shall be verified. Vendor shall also supply the necessary test certificates issued from reputed testing agencies for IEC 60870-5-104 and 61850 compliance for the complete SCADA equipment;

(ii) The Master station with RTU simulator tool shall be used to test the communication interfaces of Master station, RTU and Protection relays. The Master station simulator tool shall be capable of emulating the master station for IEC 60870-5-104 and IEC 60870-5- 103 protocols.

(iii) The RTU shall be interfaced with Energy meters on Modbus protocol and displayed with measurands at OCC end in SCADA Single line Diagram.

(iv) The RTU simulator shall be capable of emulating the slave protocols for both the IEC 60870-5-104, and IEC 60870-5-103 protocols for Protection relays. It shall also be possible to transmit illegalmessages, such as messages having invalid checksum;

(v) The protocol analyzer shall be used to monitor all communication traffic on a channel (between Master station & RTU and between RTU & protection relays) without interfering channels operation. Channel traffic captured in the active or passive modes of operation shall be displayed;

(vi) RTU functionality Test:

(a) Visual Examination: RTUs shall be inspected for the features indicated in the specification and the approved Drawings.

(b) Detailed Architecture and features: Verification of design requirements as stipulated;

(c) Functional testing on all communication devices including media converters, LAN equipment etc. shall be carried out to verify their operational parameters;

(d) Transducers accuracy shall be verified over the entire range for linearity and accuracy;

(e) Functional tests shall be conducted on the power supply unit:

(i) Stability of output voltages with the variation of input DC (94-121V) voltage;

(ii) With 120% of the normal designed rated load, the voltage regulation and the ripple factor.

(f) Insulation resistance Tests: Insulation resistance of cables shall be checked without connecting electronic circuits between various circuits, contacts, and terminals with a 500 V Megger. It shall not be less than 5 mega Ohms.

(2) SCADA Software functionality tests:

(a) All SCADA Software functional features mentioned in this specifications shall be verified,

(b) Sample SLD's for one station of each type shall be made available and verified for look and feel, ergonomics, and symbols used, interlinking of various Pictures and operation mechanisms, alarm & event log with <1ms resolution,

(c) Command execution time verification with minimum four online RTU's.

(d) Status updates time verification with minimum four online RTU's.

(e) Bus bar coloration performance verification. With minimum fouronline RTU's.

(f) Verification of various authorization levels and passwordprotections in the system.

(g) hot and standby switchover, self-check and diagnostic features etc. shall be verified,

(h) PC/Servers/Printers for OCC etc. shall be checked as per approved Drawings.

10.13.3 Environment and EMI test on RTU

(1) The following tests shall be conducted on the offered RTU sub assemblies (cards/modules) or reports of type tests carried out at Government testlabs/institutions/NABL accredited testing labs or any other lab acceptable to Engineer shall be produced.

Sr. No.	Title	Standard No.
1	High Frequency test	IEC 60255-22-1, class – III Frequency : 1MHz Damped Oscillatory Longitudinal :5 kVp Duration: 2 sec. Between input current Terminals
2	Electrostatic discharge Direct application and Indirect application	IEC 60255-22-2 Class III and IEC 61000-4-2 class III. Contact discharge: 6kV,Air discharge: 8kV Polarity: both +ve and –ve polarities. IEC-61000-4-2, Class-III
3	Fast transient disturbance	IEC 60255-22-4 and IEC 61000-4-4, class A 1.2kV; 5/50ns; 5kHz burst duration = 15ms. Repetition rate 300ms; Both polarities; Ri = 50Ω; Duration 1 minute
4	Surge immunity test	IEC 60255-22-5 / IEC 61000-4-6 class 4 Differential Mode = 2kV Common Mode = 4kV 1.2/50uS , 5 surges of each polarity
5	Power frequency immunity test	IEC 60255-22-7, Class-A
6	Power frequency	IEC 61000-4-8, Class-V
7	Radiated electromagnetic field disturbance	IEC 60255-22-3 EN 61000-4-3 Frequency 80MHz – 1GHz
8	Conducted Disturbance induced by Radio Frequency field	IEC 60255-22-6 / IEC 61000-4-6: 1996. Freq. 150kHz – 80MHz, Amplitude 10 V, : Modulation 80% AM @ 1 kHz
9	AC Ripple in DC supply Test	: IEC 60255-11
10	Radiated emission:	: IEC 60255-25
11	Dry heat test at 70^{0}C in operational condition for 96 Hours.	
12	Damp heat test at 40^{0}C and 95 % RH in operational condition for 10 hours.	
13	Cold test at 0^{0}C operational condition for 16 Hours.	
14	Cyclic heat test at high temperature at 50^{0}C and low temperature at -2.5^{0}C; Dwell time in high or low temperature for 3 Hours. Transition of10^{0}C per minute, and for 5 such cycles in operational condition.	

(2) The vibration test specified as under shall be conducted on the complete assembled.

(3) Vibration test with severity of weight centered endurance by sweep frequency 10- 50 Hz, displacement of 0.15 mm acceleration of 2 g and of duration of 2 Hours in each axis. (Total 6 Hours).

10.13.4 Site Acceptance Tests

(1) Tests shall be carried out during erection/commissioning of the equipment at site on the complete system in the presence of the Engineer to check the proper erection and successful commissioning of the equipment. These tests shall be carried out to check the compliance of the SCADA system with the stipulations made in the specification Drawings.

(2) SCAN time, cyclic update time and command operation time shall be measured.

(3) Complete SCADA system working after full configuration shall be verified.

(4) System response to abnormal conditions shall be verified.

(5) Site tests shall include tests with different types of simulated faults and with different values of measured parameters. The tests proposed to be performed for this shall also form part of Test Plan to be submitted as per clause 10.13.1 (b) of PS.

(End of Chapter 10)

CHAPTER 11 - INSTALLATION

11.1 GENERAL REQUIREMENTS

11.1.1 The Contractor shall comply with all Enactments in executing the Works, including but not limited to all statutory provisions on occupational health, safety and environment.

11.1.2 The Contractor shall co-ordinate with Other Contractors in the execution of the Works.

11.1.3 The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.

11.1.4 The Contractor shall mobilise a team of competent professionals whose CV shall be approved by The Engineer. The installation of all equipment shall be undertaken at all times by suitably trained and competent employees with previous experience of similar work of the Contractor, to the satisfaction of the Engineer. The Engineer/Eemployer reserve the right to seek replacement if not satisfied with the qualification of any Professional. Any incomplete submission (not fully complying the educational and experience criterion etc.) of CV of the professional by Contractor shall not be considered as the submission.

11.1.5 Only appropriate tools, plant, equipment and vehicles shall be used. The Engineer reserves the right to prohibit the use of particular tools and vehicles.

11.1.6 Installation of all equipment shall be in accordance with the Construction and Installation Plan described in Chapter 8 of the General Specifications.

11.1.7 Installation of all equipment shall conform to the best industry practices.

11.1.8 Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

11.1.9 The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices. These hazards shall be clearly identified in a hazard log that is included in the method statement. These hazards shall be briefed to all site staff at the beginning of each shift. All site staff will sign the briefing sheet.

11.1.10 The details on Site safety management are described in the GS.

11.1.11 The Contractor shall ensure that all areas of work are sufficiently illuminated for the works to be undertaken and that a safe system of work is employed for all activities as required.

11.1.12 The Contractor shall operate a robust system for the control of persons entering or working upon the site. The system shall include as a minimum:

(1) Register of all employees;

(2) Personal identification, with photograph;

(3) Levels of competency;

(4) Date of issue;

(5) Date of expiry;

(6) Signature; and

(7) Register of all visitors.

The site identity pass shall incorporate measure to ensure that the pass cannot be easily counterfeited, forged or copied.

11.1.13 The Contractor shall co-operate, at all times, with the Engineer and Other Contractors to ensure that the Site is protected from unauthorized admission, either wilfully or otherwise.

11.1.14 The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

11.2 SPECIFIC REQUIREMENTS

The installation work pertaining to this Contract shall include, but not be limited to the following: -

(1) Finalization of the Construction and Installation Programme;

(2) Survey on Site and review the technical requirements shown in this Specifications and the Employer's Drawings;

(3) Production of the calculation sheets and installation Drawings for Site installation;

(4) Installation in accordance with the finalized installation Drawings;

(5) Co-ordination with Other Contractors;

(6) Submission of the installation reports and records;

(7) Testing and commissioning, as per finalized protocol and programme.

(8) Production of as-built Drawings, documents, calculation sheets, and records.

11.3 CONSTRUCTION AND INSTALLATION PLAN

11.3.1 The Contractor shall undertake installation work in stages as shown in the detailed installation programme. Installation, testing and commissioning of later stages shall not impact revenue operation of earlier stages.

11.3.2 As a minimum, the detailed Construction and Installation Plan shall include but not be limited to the activities described above and in GS Vol. I — Chapter 8 on Supply, installation, testing and commissioning. Details of all activities related to installation, methods of installation, equipment, vehicles and tools to be used, safety issues considered supervision and skilled staff to be used for the activity shall be elaborated.

11.4 MATERIAL HANDLING

11.4.1 To provide for handling of consignments during construction and also needed during the life of the installation, the contractor shall provide a suitable means or an unloading gantry with a manually operated Chain Pulley hoist of Suitable rating (tonnage) on an unloading platform having the road approach of the switch yard in each Traction Substation, Sub-Sectioning Post and Sectioning Post, as a part of the Permanent Works by Contractor.

11.4.2 The Contractor shall provide the approach roads inside the Power supply Control Posts TSS, SSP, SP suited for carrying equipment of highest weight like transformer.

11.4.3 The Unloading platform constructed by the Contractor shall also be of same application duty requirement as the heaviest equipment may be unloaded at such platform including for maintenance, if any.

11.4.4 The Contractor shall have their own means to shift the material to the worksite including the transportation vehicle and the approach Road connecting to TSS/SSP/SP/ATS (if any)/SS.

11.5 MATERIAL HANDLING PLAN FOR EQUIPMENT

11.5.1 The Contractor shall prepare a material handling plan for TSS, SSP, SP, ATS (if any) and SS for movement and installation of bulky items such as transformers, 220/132 kV, AT & 25kV switchgear and OHE Masts/portal, contact wire and catenary wire and other bulky material.

11.5.2 The Contractor shall comply with the requirements specified in the GS (General Specifications) in relation to the use of works sites allocated to the Contractor.

11.6 WORKS TRAIN

11.6.1 The contractor shall provide sets of High Output Work Trains for construction of the OHE. The sets of work trains should be adequate to commence and continue works simultaneously on all the sections of work as soon as the track access of work site is available. These work trains shall include mast erectors , mast transport, wiring train with platforms for fixing wires and installing droppers and instrumentation for expeditious progress.

11.6.2 For use of any Works train, the Contractor shall ensure the safe loading, adequate steps taken against shifting while in motion and ensure that the dimensions of the materials and / or equipment carried under no circumstances shall infringe the Schedule of moving dimensions stipulated for Indian Railways.

11.6.3 The Contractor is advised to carefully consider the Works Trains design so that the working platforms have the flexibility to enable the train to pass the height restrictions and yet be of sufficient height for safe and efficient installation of the OHE on site.

11.7 INSTALLATION OF CABLES

11.7.1 The Contractor shall co-ordinate with the other Contractors for the installation of cables in cable trenches, ducts, troughs, risers and under track crossings.

11.7.2 All the cables laid in the TSS/SSP and SP shall be laid in Covered Masonry/ RCC trenches as per relevant standards, however, at stations or in City/ Municipal/ LocalBodies, the cables may be required to be laid buried under ground. Directly Buried cables shall be laid/ organised as per IS 1255. The Buried cables shall be protected against mechanical damage and water absorption (bricks shall not be less than Class Designation 7.5). Bricks over the cables shall be laid length-wise across the cable route and breadth-wise along the cable route.

11.7.3 Cables laid in the trenches shall conform to IEC 61537, IEEE 525. The Cable containment and support system shall conform to IEC 61537.

11.7.4 The cable system shall, during installation, be fully protected from mechanical damage and be generally accessible at all points for inspection along its entire route as per IS 1255.

11.7.5 Suitable cable markers shall be provided for covered cables upon completion of installation.

11.7.6 Should it prove necessary to cut any cable during installation, all cut ends shall be properly sealed until use.

11.7.7 The maximum pulling force of any cable during installation shall not exceed the manufactures recommended design force of the cables.

11.7.8 The Pull pits shall be provided for directly buried cables, laid in Pipes.

11.7.9 All cables shall be laid and suitability clamped in the cable trenches, and for the shafts, under track crossings, hangers, trays and brackets.

11.7.10 The minimum manufacturer's recommended bending radius of the cables shall not be exceeded during installation.

11.7.11 All materials used for termination, jointing and installation of cables in confined spaces shall have flame retardant, low smoke, halogen free characteristics.

11.7.12 Cable joints and terminations should comply with EN 60502, EN 60840 as per the insulation class.

11.7.13 The Cable containment and cable sizing designs shall be revalidated with the spacing of cables laid and the cable containment finally executed and suitably corrected for better cable life.

11.7.14 The width of under ground cable trench for single cable shall be 350 mm (minimum) and for two cables shall be 450 mm (minimum) and for three cables shall be 700 mm (minimum). Brick on edge shall be laid in between the two juxtaposed cables. On the top protection bricks shall be provided to cover entire width of trench.

11.7.15 GI pipes of not less than 75 mm dia, ISI marked and not less than class-B, shall be laid under the railway tracks/roads for crossing the cables.

11.7.16 Cable route markers shall be provided along the cable route at locations generally at intervals not exceeding 100 m and on change of direction of cable route and at location of under ground joints. All parts of the route marker shall be galvanized. Route marker shall be grouted in M15 grade concrete cube of size 150x150x150mm and upper most part of cube shall be minimum 200 mm below the ground. On one side "440 volt & danger sign in skull" and on other side HRIDC shall be inscribed. Both sides of route markers shall be painted in yellow colour and shall be submitted for approval of Engineer.

(End of Chapter 11)

CHAPTER 12 - TESTING, COMMISSIONING AND TAKEOVER

12.1 GENERAL

Tests shall be performed in accordance with Employer's Requirements, Part 2, Section VI, Vol-1, Chapter 8 of General Specifications - Supply, Installation, Testing and Commissioning of General Specifications and specifications/ provisions mentioned below:

12.2 CONTRACTORS RESPONSIBILITIES FOR ON-SITE TESTING

The contractor shall submit Test Plan for Total system as well as for different subsystems (TSS, SP, SSP, OHE, SCADA etc.) and major equipment (Switchgear,Transformers, CT, PT, Cables, Control Panels, Distribution Board, Battery and its charger, Isolators etc.) in accordance with:

(i) Relevant Indian standards;

(ii) Tests as given in the applicable Standards for equipment / Subsystem;

(iii) Manufacturer's recommendations for tests after installation.

The Test Plans should include but not limited to:

(i) Test to be performed furnishing a list of the tests identified in the relevant Standards and Technical Specifications and Tests Proposed to be carried out and witnessed with break up in to FAT, Site tests and Acceptance Tests,

(ii) Test Procedures for each test proposed including precautions to be taken during tests,

(iii) Test equipment/ instruments and measuring instruments to be used,

(iv) Parameters to be checked,

(v) Criterion for acceptance / rejection, acceptable Values,

(vi) Test Program

(vii) Any other relevant information,

The tests shall be conducted after the test plans have been approved. Record of such tests with observations and obtained result shall be maintained.

12.2.1 Traction Power Energisation of the track shall be carried out progressively in stages. For the energisation of section (including tunnels) in stages, sectional turn-on of 25 kV AC power may require putting up of temporary works e.g. cable diversion, additional earthing provision, etc. to ensure the safety of workers working in the adjacent area. Such work inclusive of sectional testing of traction power shall be deemed to be included in the scope ofContract. The OHE (and ROCS in tunnels) commissioning shall include as a minimum in conformance to EN 50119/ relevant standards and the guidelines specified in ACTM and specified by RDSO :

(1) **Visual inspection:** This shall include check for accuracy of construction for ensuring that all the structures, equipment, insulators, jumpers and conductors have been erected as provided in approved Drawings and they are not damaged and remain in healthy state.

(2) **Dimensional Checks:** This shall include dimensional checks to ensure the execution of permanent Works are within the limits of tolerance permitted so as to permit the current collection by locomotives to be satisfactory.

(3) Final Physical Check

This shall validate as a minimum that all temporary earths are removed, wires are present and in good condition, nothing is fouling with the OHE/ROCS and all insulators are undamaged and present and auto-tensioning devices are installed and are functional. All sections of OHE/ROCS spans are provided with connectivity jumpers.

(4) Earthing and bonding

All earthing and bonding arrangements have been completed.

(5) Section proving

This test shall be undertaken in each electrical section, to ensure that each electrical section can be successfully isolated from adjacent electrical sections and that the correct OHE alive indications are shown in the TSS control rooms and the on the SCADA system.

(6) Clearance for Test Charging

The contractor shall ensure that all equipment, tools and M&P are removed from the site and the OHE/ROCS Equipment are free from any hindrance, physical obstruction, and is safe for personnel, before seeking clearance from the Engineer for test charging.

(7) Anti-Theft Charging of OHE

(a) As an anti-theft measure, the OHE after erection shall be charged at 2.2kV by the Contractor. All arrangements for taking supply from the supply authority or otherwise shall be done by the contractor. However, before such anti-theft charging safety of Personnel of all the contractors and of Employees of adjacent Railway System has to be ensured. This includes:-

(i) Permission of the Employer.

(ii) E.I.G. Sanction,

(iii) Appointment and Placement of authorized personnel.

(iv) Issue of public notice in Local Newspapers for information to public.

(v) Notice to adjacent Indian Railway Administration.

(vi) Procedure providing for issue and cancellation or permit to work on or in vicinity (within two meters of the conductors & 25 KV equipment) to all concerned through and to authorized Personnel as a requirement before the lines can be charged as an anti-theft measure. The list of authorized Personnel shall be approved by the Engineer and provided to all the concerned authorities. Procedure of issue and cancellation or permit to work shall be approved by Engineer.

(vii) Control Room for 24X7 hour monitoring of the charged sections and its patrolling. Communication facility to enable monitoring of the OHE and management of Permit TO Work (P.T.W.).

(viii) Issue of certificate to authorized Personnel for charge & discharge of line.

(ix) Communication with patrol party and control room.

(x) Attending to alarms.

(b) The contractor shall give notice to all the designated Contractors, who will take necessary precaution while carrying out the works keeping in view the anti-theft charging of OHE. This antitheft charging shall not be done until "no objection" is received from the Engineer and confirmation received from him that IR staff of adjacent linking station and DFC linking station have been warned of the hazards of adjacent line of HORC being charged and have been trained on the precautions required to be taken by them.

(c) Detailed rules shall be prepared by the Contractor and put up to the Engineer for approval & issue to all concerned.

(8) Tests Prior to Commissioning of a section

(a) Short circuit testing

Each electrical section shall be subject to electrical short circuit test at the remote end under normal feeding and one short circuit using the extended feeding arrangements. This test shall confirm the mechanical integrity of the OHE and validate that the substation protection systems function correctly.

(b) Steady current tests.

The steady current test shall be undertaken in each block between TSS and the adjacent TSS. This test shall be used to validate the EMC safety case, validate protection system and to confirm the currents in earthing and bonding cables and to allow the measurement of accessible voltages at strategic point in each electrical section.

12.2.2 The Contractor shall not energize the TSS, SP, SSP, SS or the OHE until all interfacing parties have issued a letter of no objection. Once all interfacing parties' letters of no objection have been received then the Contractor shall apply to the Engineer to seek a letter of no objection to proceed with Energisation of the electrical section.

12.2.3 The Contractor shall be responsible for surveillance and security of the power supply systems including padlocking or otherwise maintaining control of the substation, padlocking of Switchgear and circuit breaker units, distribution switchboards, power panels, etc. throughout all Energisation stages of the installation.

12.2.4 The Contractor shall interface with the other Contractors to ensure no downstreamcables or other electrical equipment is energized before it has been tested and before other involved Contractors facilities are ready and secured.

12.3 RE-TESTING

12.3.1 When defects are detected in the equipment accessories, etc. during the commissioning tests, the Contractor shall ensure that adequate spares are kept on site to promptly attend to such defects.

12.3.2 In the event of the defect on any item being of such a nature that the requirements of these Specifications cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor at his own expense, after carrying out the tests as per the relevant specifications for acceptance by the Engineer.

12.4 INSTALLATION TESTS

12.4.1 An inspection and visual verification of ratings and connections of equipment, instrument transformers and auxiliary circuits, installation tests shall be carried out.

12.4.2 After installation of equipment, visual inspection and operational tests on un-energized equipment shall be carried out to check the following:

(1) Cleanliness;

(2) Workmanship;

(3) Confirmation of items conforming to ratings specified;

(4) Water and dust proofing;

(5) Leveling, mounting and positioning;

(6) Joints and connections tightness;

(7) Cables – dressing, bending radii, jointing and finish at terminals;

(8) Clearances and dimensions in conformity with Drawings;

(9) Earthing and bonding;

(10) Functioning of circuit breakers, isolating switches and their interlocks;

(11) Protection devices;

(12) Phase sequence verification;

(13) Conforms to as-built records.

12.4.3 Earth resistance measurements shall be carried out individually for the subsystem andthe system as required.

12.4.4 Insulation Resistance

The Insulation resistance of all 220/132 kV ac and 25kV circuits shall be tested with an Insulation tester of 5 kV. All LV circuits comprising ac and dc auxiliary circuits shall be tested with a 500 V Insulation tester.

12.4.5 Continuity Test and Contact Resistance

Continuity of all circuits shall be verified. Contact resistance of all high current joints and bolted contacts, especially the joints of 25 kV conductors and the running rails for return current shall be measured with a Ductor set with a resolution of 1μΩ. Earth system joints shall also be measured.

12.4.6 Protection Equipment

(1) Tests on Current Transformers

(a) Insulation resistance

(b) Winding resistance

(c) Polarity or Connections up to equipment terminals.

(d) Ratio and magnetization curve verification

(2) Tests on Voltage Transformers

(a) Voltage ratio

(b) Insulation resistance

(c) Polarity of connections up to the equipment terminals.

(3) Secondary and primary injection tests

Tests shall be carried out at a minimum of three settings if multiple settings are available. Test results of operation boundaries and operating times shall be recorded.

(4) Batteries and Chargers

(a) Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger.

(b) Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures.

(c) No addition of electrolyte is permitted during discharge tests.

(d) The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.

(5) Control, Indication and Alarm Functions

(a) Insulation resistance and continuity of all cores of cables shall be identified and tested.

(b) The correct functioning of all control, indication and alarm devices shall be verified.

(6) Switchgear

(a) All switchgear, including circuit breakers, interrupters, isolating and earthing switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory.

(b) SF6 gas leakage test shall be performed where applicable.

(c) Closing time for all circuit breakers shall be verified.

(7) Instruments and Transducers

All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

(8) Power Transformers

(a) Voltage ratio at all taps, functioning of tap changers and Insulation measurements shall be performed.

(b) Oil circulation and oil testing shall be performed.

(c) Simulation tests shall be carried out to determine correct operation of all protective relays.

(d) Test shall be undertaken in accordance with those set out in the Transformer specifications in chapter 19 Appendix – 8 & 9 of PS.

12.5 PARTIAL ACCEPTANCE TESTS

12.5.1 These tests form part of on-site and System Acceptance Tests as part testing of the equipment and system.

(1) Functional Tests and Interlock Tests

(2) All control and protection functions and electrical/mechanical interlocks shall be tested.

(3) Primary Injection Tests

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

(4) AC/DC Pressure Tests

(a) The Insulation resistance of all circuits shall be measured before and after the dc pressure test. The minimum phase-to-phase and phase-to-earth Insulation resistance shall be as per relevant standards.

(b) Pressure tests shall be carried out on completed cable lengths of highvoltage cables in accordance with IEC 60502.

12.6 SYSTEM ACCEPTANCE TESTS

12.6.1 Energisation

(1) The Contractor shall prepare operation safety rules and procedures for the review of the Engineer before Energisation.

(2) The Contractor shall carry out all necessary checks to ensure safe Energisation.

(3) The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Engineer, the Contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment or of overhead equipment or connections of traction lines.

12.6.2 Tests

System Acceptance Tests shall include but not be limited to:-

(1) Functional tests of SCADA system

(2) Integrated Tests with Engineer's Train Operator

(3) Short Circuit Tests on OHE

Short Circuit Tests on 25kV overhead lines shall be carried out to prove correct operation of protection equipment and to ensure that the dynamic strength requirements of overhead equipment are met. Short Circuit Tests shall be carried out on every overhead equipment line feeder (OHE to Earth, NFW to Earth, OHE to NFW, OHE to ballast and NFW to ballast). Contractor shall submit method statement of short circuit test for review of Engineer.

(4) Current Collection Test

The contractor shall conduct current collection tests as per EN 50317 to demonstrate that newly installed OHE satisfies the quality requirement for maximum test speed. The behavior of the OHE shall be watched at various speeds. Current collection shall be considered unsatisfactory, if any blue flash/ spark is observed, indicating that the contact between the pantograph and contact wire is not smooth. In such cases remedial action shall be taken to rectify and restore smoothness in the contact wire.

(5) Dynamic Validation

(a) Dynamic validation shall be undertaken to ensure compliance with the specified current collection criteria of all relevant parts of the work including track work, rolling stock and catenary interfaces.

(b) The criteria for measurement shall be loss of contact with measurable arcs lasting longer than 10ms (maximum 25ms) shall not occur more than once in 100m.

(c) The Contractor shall agree with the Engineer the selection of a suitable method and equipment, which determines compliance with the current collection standard within the range of operating conditions.

(d) The system dynamic performance shall comply with the requirements of EN 50119.

(6) Earth Fault Test on OHE

Earth fault tests shall be conducted on OHE traction wires and feeder wires to prove correct operation of protective equipment as described in ACTM. The fault distance from nearest operational circuit breaker shall be validated during the test.

12.7 INTEGRATED TESTING AND COMMISSIONING

12.7.1 Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the railway systems operate satisfactorily between one another and meet all specified requirements for design, operability, safety, and integration with other works and systems. Integrated Testing and Commissioning shall comply with the requirements of EN 50317, EN 50367, IEC 62427 and IEC 62313.

12.7.2 These tests shall be entirely within the requirements of one or more of the Project Contracts or they shall involve a multiplicity of Contract procedure. The final Integrated Testing and Commissioning shall be carried out after the SCADA system and OCC have become operational.

12.7.3 Those systems that can be tested without depending on the running of trains, such as SCADA system, etc. will have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these "train less" system tests be identified and resolved prior to the commencement of test running.

12.7.4 The following is an indicative listing of those Integrated Testing and Commissioning functions that are necessarily to be integrated with others to demonstrate that the equipment and controls installed therein meet the Contract Specifications and demonstrate a safe-to-operate condition. This list is not exhaustive and the same shall be updated by the contractor, to demonstrate functionality, completeness and safety of the installed works. The updated list shall be approved by the Engineer

(1) Load sharing test between traction transformers during train acceleration.

(2) Load measuring test for circuit breakers.

(3) Harmonic measurement.

(4) TSS, SSP, SP and SS failure mode test.

(5) Remote control and monitoring test through SCADA system at OCC.

(6) Power system functional tests.

(7) EMI/EMC tests.

(8) Touch/step potential tests (in TSS/SSP/SP and in OHE/ROCS).

12.7.5 On-load Tests and Directional Tests

Once sufficient load current is established, voltages and currents into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

12.8 SERVICE TRIALS

The Contractor shall provide special and general attendance during the Service Trials period such that the persons who carried out the On-Site Testing and Commissioning are available on Site to solve any problem arising from the Service Trials.

12.9 PERFORMANCE VERIFICATION

12.9.1 The Contractor shall carry out all Performance Tests to verify that the performance of the System meets the Employer's Requirements after substantial completion of the Works.

12.9.2 The Performance Tests shall be carried out by the Contractor in conjunction with relevant parties (e.g. Indian Railways).

12.9.3 The measurement of EMI levels shall be carried out prior to Energisation of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels comply with the requirements of these Specifications.

12.9.4 Should the performance of the System deviate from the Particular Specifications, the Contractor shall make every effort to rectify the deviation in the shortest possible time, and to the satisfaction of the Engineer.

12.10 TRACTION INSTALLATION TAKE OVER

12.10.1 The conditions for Takeover of the Traction installation are as follows:

(1) The Contractor shall hand over the HORC sections of the traction installation to the Engineer on the Co-ordination Dates as per Conditions of the Contract. From this date, any access to the Railway Installation by the Contractor shall be in accordance with any procedures, requirements and conditions laid down by the Engineer.

(2) At the time of Takeover, the Contractor shall have executed all the works of Employer's requirement as described in GS and PS (Volume 2) including structures, all safety works, screens, barriers from High Voltage and affixed all Safety and Warning Sign boards and all other works provided by the Contractor within the Railway Envelope, the installation of all equipment and fixings defined under relevant chapter(s) and shall ensure that the Envelope is complete, secure, safe for the operation of trains, and has the Engineer's approval for effective Takeover.

(3) Prior to the issue of Taking Over Certificate, the Engineer will ensure the completion of following activities:

- Testing of traction equipment and other equipment and facilities required for operation of the railway.
- Acceptance tests and Integrated System Tests;
- Trial running: during this period the Engineer will be operating trains and equipment on a trial basis, the frequency of which will increase as the trials proceed until full operating frequencies & performances are achieved.

12.10.2 The conditions for access to the HORC Railway Envelope after handover are as follows:

(1) Access to the HORC Railway Envelope after takeover will be controlled by the Engineer. Access will be given to the Contractor and to other contractors by the Engineer for inspecting, maintaining, adjusting and repairing, by prior arrangement

and for limited periods. The work on High Voltage sections will be subject to 'Permit to Work' procedure.

(2) At the time of Takeover, the Contractor shall nominate a responsible In-charge and a person contactable on twenty-four (24) hour basis to liaise with the Engineer during Defect Notification Period. The Contractor shall give two weeks' notice of his desired track and /or High Voltage equipment possessions, and, when requested, at the appropriate meetings, track possession and or Traction Installation possession allocations will be made by the Engineer. It may be necessary for the Contractor's work to be carried out intermittently or at night, if suitable possessions cannot be given during its preferred hours. During all such operations the Contractor will be fully responsible for safety of men, equipment and Works.

12.10.3 The Contractor shall take into account of the Engineer's activities and train operations in planning and programming its Works.

(1) The conditions for access to the HORC Railway Envelope on the Work Site after issue of Taking over Certificate on completion will be administered by the Engineer.

(2) Prior to the substantial completion of the Works, the Contractor will be given extended possessions of the Railway Envelope for the purposes of final adjustment, tightening, touching up or cleaning up prior to the final inspection of the Works. Such possessions shall be agreed with the Engineer.

(3) Safe Earthing and Bonding of the Traction Installation, screens and access barriers against exposure of 25 kV ac, supply to public and unauthorized personnel etc. as required in terms of safety provisions of relevant standards and safety regulations shall be supplied and installed by the Contractor before the Takeover of the Traction Installation by the Engineer.

(End of Chapter 12)

CHAPTER 13 - SPARES, SPECIAL TOOLS, TESTING & DIAGNOSTIC EQUIPMENT AND MEASURING INSTRUMENTS

13.1 GENERAL

(1) The Contractor shall supply the spares as detailed in Table No. 13.2.1 below, not later than Six weeks before the start of Defect Notification Period to ensure availability.

(2) In addition, the Contractor shall submit to the Engineer a Schedule of Recommended Spares including consumable, duly indicating for each item, description, part number, drawing number, lead time, shelf life and number of units having due regard to the lead time of respective Spares.

(a) The Contractor shall base the spares calculations on the reliability and availability data and the criticality of the equipment and submit these calculations to the Engineer for review.

(b) The Schedule of Recommended Spares shall:

i be grouped by plant & equipment, manufactured items and system/sub-system, test equipment and special tools as applicable for stocking identification;

ii Have detailed description with drawing references and correlation with the maintenance manuals.

(3) The Contractor shall submit the name(s) & address(s) of primary and secondary source(s) of all the spares, who shall supply the spares and consumables.

(4) In the event that any of the spares identified have a particular shelf life or special storage requirement, this shall be made known to the Engineer with the submission including the necessary action for disposal or storage.

(5) All spares shall conform to Identification and Configuration Control requirements established by the Contractor for the equipment provided under the Contract.

(6) Testing of the Spares - The Contractor shall ensure that all spares are correctly calibrated, tested and labeled prior to their delivery. Test/Calibration Certificates for each one of the spares shall be submitted to the Engineer.

(7) All kinds of consumable not limited to printer cartridges, tapes and papers etc. shall be supplied by the Contractor for the period upto the handing over of theWork to the Employer.

13.2 CONTRACT SPARES

The Contractor shall supply Spares as given below.

Table 13.2.1: Quantity of Contract Spares

S. No	Item Description	Quantity
A1. OHE Spares		
1	**All types of structures including portal par**ts	2% of each type used for the project subject to min of 10 nos. and Maximum of 20 nos.
2	catenary and contact Conductors, Fittings, hardware and all types of Jumpers & droppers	2% of Installed quantity Km
3	Set of Cantilever Brackets with insulators	50 nos.
4	9-T insulators	75 nos.
5	Feeder Conductor	2 kms
6	Aerial Earth Wire and BEC (if required)	10 km each
7	OHE Section Insulators	10 sets
8	OHE Auto-tensioning device sets	10 sets
9	Counter weights for ATD	10 sets
10	Stainless steel wire rope for ATD	20 sets
11	PTFE type Neutral Section	5 sets
12	Splices for conductors, feeders	10 nos. for feeder wire 50 nos. for Contact wire, 50 Nos. for Catenary Wire and minimum of 10 nos. of splices of each type of other conductors used such as Large Span wire etc, AEW, BEC (if required).
13	Spares for OHE other than above (1 to 12)	2.5 % subject to minimum 10 nos. and subject to quantity in whole nos. next higher no/ weight for hardware items
A2: ROCS Spares		
1	Conductor Rail	500 m
2	Support (drop arm) assembly cantilever arm along with swivel head, anchor bolts, support insulator bolts with all hardware complete (except support insulator)	20 nos.
3	Support Insulator	50 nos.
4	Anchor assembly	2 nos.
5	Expansion joints	2 nos.
6	Air gap section	2 nos.
7	Transition arrangement	4 nos.
8	ROCS protection cover	10 nos.
9	Conductor rail expansion joint jumpers with fasteners	2 sets
B : PSI (TSS,SP,SSP) - Spares		

1	LA for 220/132 kV	2 nos each type.
2	LA 42 kV	5 Nos.
3	25kV PT	5 Nos.
4	25kV CT	2 each type
5	Double pole Interrupter 55/2x25kV	2 Nos.
6	Double pole Isolator motor operated 55/2x25kV	4Nos.
7	Double pole CB 55/2x25kV	2 Nos.
8	220/132 kV CB	1 no.
9	220/132 kV CT	1 no.
10	Isolator 220/132 kV	1 no.
11	String insulators 220/132 kV	2 sets
12	Post Insulators 220/132 kV	2 nos.
13	Post Insulators 25 kV	20 nos.
14	Auto Transformer	1 No suitable for TSS and 1 no suitable for SP/SSP on short circuit capacity)
15	Auxiliary Transformer 100 KVA	1 nos.
16	Auxiliary Transformer 50 KVA	2 nos.
17	Auxiliary Transformer 25 KVA	4 no.
18	CTs, PTs and other Accessories as used for the project	Minimum 5% subject to Minimum of 3 nos.
19	PSI (TSS, SP, SSP) - Spares other than item 1 to 18 above (connectors, jumpers, hardware, bus bars etc.)	5 % subject to min of 3 nos./ meter/kg and max of 10 nos./ meter /kg
20	Spares of **Auto transformer**	As per list of spares included in the specification given in relevant Chapter for required rating.
21	Spares of **traction transformer**	As per list of spares included in the specification given in relevant Chapter for required rating.
C.	**Protection and Metering**	
1	Control and auxiliary relays	1 set of each type
2	Protection relay	1 set of each type
3	Metering Relay	1 set of each type
4	Transducers	1 set of each type
D.	**SCADA System**	
1	Spare Cards for RCC/RTU	Minimum 20% spare cards but not less than Five of each type
2	Spare Cards of Each type	20% spare cards but not less than Five of each type at the time of Handing over

13.3 SPECIAL TOOLS, TESTING AND DIAGNOSTIC EQUIPMENT AND MEASURING INSTRUMENTS

(1) The Contractor shall submit a schedule of recommended Tools and Test equipment with details of calibration and supplier(s).

(2) The Contractor shall supply at least six weeks before the start of Defect Notification Period, the Tools and Test Equipment for various Systems/Sub- Systems, which are essential for day to day use in both corrective and preventive maintenance and for workshop use in repairing of modules/units.

(3) The Contractor shall supply the Tools and Test Equipment as detailed in table 13.3.1 and 13.3.2 below.

Table 13.3.1: List of Special Tools and Instrument

S. No	Description	Quantity in No's
1	Cable Fault Locator	1 sets
2	AC Power Line Analyzer	2 nos.
3	Digital earth testers	3 nos.
4	Earth Leakage Detector 1000 V	3 nos.
5	Digital Insulation Tester 2.5/ 5 kV	3 nos.
6	Digital Insulation Tester 0 – 1000 V	3 nos.
7	Dynamo Metre (5.0 T x 20 Kg)	1 nos.
8	Binoculars	1 nos.
9	Vernier Caliper	1 nos.
10	Walky Talkie Set	6 nos.
11	Emergency Telephone	7 nos.
12	Primary injection test kit	1 nos.
13	Secondary injection test kit	1 nos.
14	Relay Testing Kits	1 nos.
15	Infra-red remote temperature sensor	2 nos.
16	Fully automatic Oil dielectric test kit with printer	1 nos.
17	i) Thermal Imaging Camera capable of being mounted on Tower Wagon /loco ii) Hand held Thermal Imaging camera	2 nos. 2 nos.
18	Video Camera	2 nos.
19	Height and Stagger gauge (instrument laser based)	4 sets
20	Dissolved Gas Analyzer set	1 nos.
21	Hydraulic Compressor for Aluminum conductor Splicing Zig (all sizes)	1 sets
22	Turfers all weight categories	10 each type
23	Pull lift all weight category	10 each type
24	Come-along clamps for different conductors	20 for each size
25	Discharge Rod complete including earthing cable and connectors	20 nos.
26	Aluminum Ladders (5 m and 11 m extendable)	15 each
27	Portable petrol/ kerosene set 1.5 KVA	5 nos.
28	Vehicle mounted Oil filtration plant 1 phase 3000 liters per hour capacity	1 nos.
29	Portable diesel Generating set 3 kVA 230 V.A.C.	2 nos.

30	150 sq.mm Contact wire Cutter 36"	10 nos.
31	Wire Cutter 12"	10 nos.
32	"D" Shackle set (1",3/4", 5/8", &1" One Each)	20 nos.
33	Single sleeve Pulley Block 3.5" x 5/8" Groove Fiber for drawl of contact. &catenary wire	20 nos.
34	Portable rail drill machine.	5 nos.
35	Siren 3 phase Range 5 Km and 1 phase Range 1 Km	2 each
36	Ladder Trolley capable of running on track	2 nos.
37	DE and Ring Spanner sets suitable for Fittings being supplied	20 nos.
38	Chain pulley block all weight category as required for erection	10 nos.
39	Hydraulic insulator testing jig	2 nos.
40	Copper Hammer	5 nos.
41	Nonmetallic Hammer	2 nos.
42	Micro Meter	5 nos.
43	Fiber measuring Tape 30 mtr. & 15 mtr. Each	10 nos.
44	Isolator pad lock	10 nos.
45	Neutral Section inspection Jig	2 nos.
46	Nylon rope 20 meters length	10 nos.
47	Diagnostic kit (LAPTOP) along with software capable of testing all type of modules to identify Faults	3 nos.
48	Digital Multi-meter	3 Nos
49	Portable operated tree pruner	5 Nos
50	Motorised Earth Augur	2 Nos
51	Crimping Tools for droppers/ conductors (all types)	10 Nos
52	Operating rod for DO fuse (Pull Rod)	5 Nos
53	Inflatable lighting tower	3 Nos
54	Portable Power hacksaw	3 Nos
55	Safety Helmet	50 Nos
56	Safety Harness	10 Nos
57	Hand blower	2 Nos
58	Vacuum Cleaner	2 Nos
59	Vehicle mounted Oil filtration plant 1 phase 300 liters per hour capacity	2 Nos
60	Box spanner set	3 Nos
61	Portable Tan Delta & Capacitance Measuring Bridge	2 Nos
62	Capacitance meter	2 Nos
63	Portable grinder Electrically operated	2 Nos
64	Steel sling with eye each end 1 m, 2 m and 3 m	10 each
65	Steel sling with eye each end 5 m, 10 m	5 each
66	Twister cum bender 6"	10 Nos
67	Motor Trolley	2 Nos
68	Unmanned Aerial Vehicle (drone) flight time not less than 30 minutes	1 Nos
69	Oliver – G	1 Nos

Table 13.3.2: Special Tools -Tower Wagon and Rail-cum-Road Vehicle

S. No	Description	Quantity in No's
1	8 Wheeler Tower Wagon as per RDSO's specification no. TI/SPC/OHE/8WDEIC/0092(08/15 Rev.2 or latest specification	1 No.

Contractor shall place purchase order for 8-Wheeler Tower Wagon within 90 days from the date of issue of LOA.

13.4 TECHNICAL SPECIFICATIONS FOR SPECIAL TOOLS, TESTING AND DIAGNOSTIC EQUIPMENT AND MEASURING INSTRUMENTS

The specifications of few special tools and diagnostic equipment are summarized hereunder. This list of specification is not exhaustive and may not cover all the tools, equipment and instruments. The contractor shall submit a schedule of recommended Tools and Test Equipment along with technical specifications in detail for the approval of the Engineer.

13.4.1 **Cable Fault Locator** - Voltages up to 0 ... 12 kV, display of end and fault distance, display at least 5" size, DC Hipot Function, ARM Method, Direct Thump Method, TDR Function, Sheath Test, Sheath Fault, Integrated Battery, Truly portable, rain proof and low weight, TDR options in both operational modes, QUICK-STEPS and EXPERT Mode shall be individually programmable by customer. Fault location by the magnetic field and sound signal coincidence method, Excellent acoustic characteristics (frequency range 100 Hz to 1.5 kHz).

13.4.2 **Earth Leakage Detector** - Range: 0-30 mA/300 mA/30 A/300 A, 0.01 mA resolution for measuring earth leakage currents, Jaw Opening 40 mm, Analogue Bar graph Display for trending, 300 V phase to earth and 500 V phase to phase CAT III or 600 V CAT II double insulated, Safety - IEC1010-1, EMC-IEC61326-1.

13.4.3 **Earth Megger** - 20 kilo ohms with 1 mohm Resolution with accuracy ± 0.5 %, Test Frequency: 105 - 160 Hz in 0.5 Hz Steps, Test Current : 50 mA, Maximum Output Voltage: < 50 Vrms, Maximum Interference: 40 Volts Peak to Peak (50 Hz), Measurement Standards: BS: 7430 (1991) and VDE 0413, Part 7, IP54, Safety - IEC1010-1, EMC-IEC61326-1.

13.4.4 **Digital Megger 10000 V** - Mains (without battery) operation & rechargeable battery operation, 35TOhms, Short circuit current 6 mA, noise rejection 8 mA, Guard out parallel leakage resistance with a max error of 2%, IP65 rated & CAT IV rating, Safety - IEC1010-1, EMC-IEC61326-1.

13.4.5 **Primary injection test kit** - 2000Amps @3 minutes, Open circuit voltage 6V, fine adjustment knob (Variac) on control panel with inbuilt display, positive and negative buttons for coarse adjustment of current, Design of test set should be based on transformer technology and not on spire (hole) through technology for better efficiency.

13.4.6 **Secondary Injection Test Kit** - Output AC Current 250A, AC Voltage 250V, DC Voltage 0-300V, 0-359deg, 15-550Hz, Plotting excitation curves, Current and voltage transformer ratio tests, Burden measurement for protective relay test equipment, Impedance measurement, Efficiency tests, Polarity (direction) tests, CE-marking, Weight should not exceed 19Kg.

13.4.7 **Relay Testing Kits** - Modular in Design, 6 current source - 3 X60A + 3X15A, 4 voltage sources out of which 3 are convertible to current sources - 3x300V, Max Compliance voltage L-N 50V and L-L 100V, Power Consumed 1800VAmax, Manual Control LCD Touch Screen, IEC 61850 Testing Capability, Safety - IEC1010-1, EMC-IEC61326-1.

13.4.8 **Oil dielectric test kit** - BDV 100KV with inbuilt oil temp measurement, HV switch off time shall be <10us , external calibrator, Safety - IEC1010-1, EMC-IEC61326-1 Class B.

13.4.9 **Tan Delta Kit** - Voltage 25V-12kVAC, inbuilt voltage dependency detection, automaticPF Tip up test, generate its own temperature correction factor by using variable frequency method from 1hz to 500hz, Safety - IEC/EN 61010-1:2001, EMC - EN 61326:1997/A1:1998/A2:2001/A3:2003.

13.4.10 **Measurement of Moisture in Paper by Frequency Domain Spectroscopy** - Output Voltage 200V, Output current 50mA, Frequency range 0.1mHz - 10kHz, Excitation current Measurement, Tan Delta measurement @50 Deg, Oil conductivity, Measurement time upto 1mHz would be around 22minutes, Measurement time upto 2mHz would be

13.4.11 **Sweep Frequency Response Analyser** - Frequency range 0.1 Hz — 25 MHz, No. of points Up to 32 000 points, user selectable, inbuilt Battery, 0.20 — 20 V peak to peak compliance voltages, Fulfils requirements in IEC 60076-18, IEEE C57.149-2012, CIGRE Technical Brochure 342, DL/T 911-2004, external calibrator, Safety - IEC1010-1, EMC-IEC61326.

13.4.12 **CT Analyser Kit** - Multi tap (suitable for up to 5 taps) analyzer, Ratio measurement, polarity, CT secondary resistance measurement, Excitation characteristics plot, CT burden testing, IR testing, Single Phase relay testing, standard testing procedure like IEC60044-1,6, IEC61869-1, IEC61869-6 ANSI45,30, Safety - IEC1010-1, EMC- IEC61326.

13.4.13 **Transformer and Sub-station test system** - Automated 3Phase/6winding measurement for Turns Ratio, Winding Resistance (100A/50V), Demagnetization, Load tap-changer continuity, timing and dynamic resistance measurement, Excitation Current, Leakage Reactance, FRSL and Magnetic Balance Measurement, Single Phase testing ofprimary and secondary relays, AC Insulation testing with frequency range of 1 - 505 Hz with Intelligent Temperature Correction. Primary Injection Test up to 800A, Contact Resistance Measurement up to (100A/50V), Display of the unit must be 10.4" TFT touch type with 1024x768 resolution CE- marking.

.

(End of Chapter 13)

CHAPTER 14 - RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND SAFETY

14.1 GENERAL

The Project is to be designed with high degree of reliability and availability as per Employer's Requirements, Part 2, Section VI, Vol-1, and Chapter-12 on- Reliability, Availability, and Maintainability & Safety (RAMS) of General Specifications and as per specifications / provisions mentioned below:

14.1.1 The Contractor shall demonstrate that the traction power supply and OHE/ROCS system shall meet all the RAMS requirements specified for this system. These specifications define a set of RAMS requirements for the Electric Traction System to be used, assessment and controls of threats to RAMS, Plan & Implement RAMS Tasks, demonstrate achievement of adequate Reliability, Availability, Maintainability & Safety (RAMS) Assurance. This includes the setting up a monitoring system to monitor during life cycle of compliance, Safety and RAM targets to be achieved and establishment of a Reliability, Availability, Maintainability and Safety (RAMS) assurance process to ensure that hazards are identified and managed and that the Safety and RAM targets can be shown to be met.

14.1.2 The design performance of traction system shall provide very high level of Reliability, Availability, Maintainability and Safety through RAMs analysis, which can be demonstrated through data gathered during operation of the 2 X 25 kV Traction System.

14.1.3 Terms & Definitions and Abbreviations

(1) In this document, following defined terms shall have the meanings as described here below:

Definitions	Descriptions
Apportionment	process whereby the RAMS elements for a system are sub-divided between the various items which comprise the system to provide individual targets
Assessment	undertaking of an investigation in order to arrive at a judgment, based on evidence, of the suitability of a product
Availability	ability of a product to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided
Compliance	A demonstration that a characteristic or property of a product satisfies the stated requirements.
Corrective Maintenance	maintenance carried out after fault recognition and intended to put a product into a state in which it can perform a required function
Down time	time interval during which a product is in a down state
Failure mode	predicted or observed results of a failure cause on a stated item in relation to the operating conditions at the time of the failure

Definitions	Descriptions
Fault tree analysis	analysis to determine which fault modes of the product, sub-products or external events, or combinations thereof, may result in a stated fault mode of the product, presented in the form of a fault tree
Hazard	physical situation with a potential for human injury and/or damage to environment
Hazard log	Document in which all safety management activities, hazards identified, decisions made and solutions adopted are recorded or referenced. Also known as a "Safety Log"
Maintainability	probability that a given active maintenance action, for an item under given conditions of use can be carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources
Preventive maintenance	maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item
Reliability	probability that an item can perform a required function under given conditions for a given time interval
Reliability growth	condition characterized by a progressive improvement of a reliability performance measure of an item with time
Repair	that part of a corrective maintenance in which manual actions are performed on the item
Restoration	that event when the item regains the ability to perform a required function after a fault
Risk	probable rate of occurrence of a hazard causing harm and the degree of severity of the harm
Safety	freedom from unacceptable risk of harm
Safety case	documented demonstration that the product complies with the specified safety requirements
Safety integrity	likelihood of a system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time
Safety integrity level (SIL)	One of a number of defined discrete levels for specifying thesafety integrity requirements of the safety functions to be allocated to the safety related systems. Safety Integrity Level with the highest figure has the highest level of safety integrity
Safety-critical	Failure of the system, sub-system or equipment will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.

Definitions	Descriptions
Tolerable risk	maximum level of risk of a product that is acceptable to the Railway Authority
Validation	confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled
Verification	Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled.

(1) Abbreviations

Abbreviation	Definition
ALARP	As Low as Reasonably Practicable
DT	Down Time
EN	European Norm
FMECA	Fault Mode Effects and Criticality Analysis
FMEA	Fault Mode and Effects Analysis
FTA	Fault Tree Analysis
FRACAS	Fault Report Analysis and Corrective Action System
GS	General Specifications
IHA	Interface Hazard Analysis
ISO	International Organization for Standardization
IEC	International Electro-technical Commission
MCIL	Maintainability Critical Item List
MDT	Mean Down Time
MTBF	Mean Time Between Failures
MTBSAF	Mean Time Between Service Affecting Failure
MTTR	Mean Time to Restore
O&SHA	Operating and Support Hazard Analysis
OPM	Other Preventive Measures
PHA	Preliminary Hazard Analysis
PS	Particular Specifications
RAM	Reliability Availability Maintainability
RAMS	Reliability Availability Maintainability and Safety
RBD	Reliability Block Diagram
RCIL	Reliability Critical Item List
RDT	Reliability Demonstration Testing
RTU	Remote Terminal Unit
SCIL	Safety Critical Items List
SSHA	Subsystem Hazard Analysis

14.1.4 RAMS Principles

(1) The 2x25kV, ac, Electric Traction system shall be deigned to achieve all RAM requirements specified in this PS and EN 50119.

(2) The design, manufacture, installation and commissioning of the equipment as well as training of the operating and maintenance staff shall be such that to ensure near Zero Failure performance in the initial stages and that the few defects & deficiencies that may be exposed during the Service Trial are totally eliminated.

(3) All the sub-systems and equipment to be used shall be of proven design with a high degree of reliability and in use in other similar Railway projects. Calculations shall be performed using appropriate design models involving relevant variables. The design values and verification methods shall conform EN:50119.

(4) The sub-systems and equipment shall be engineered to maximize system availability during traffic hours, to minimize the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out in minimum time, with minimum skill, and at minimum cost.

(5) Fault Tolerance & Graceful Degradation: The system shall be designed such that service can be maintained in the presence of Single point faults Scenario. Subsystems and components whose failure can significantly impact on RAM performance shall be backed up by built in redundancy in Sub-systems or components that permit continuous operation.

(6) Recovery: Provision shall be made to recover from any credible fault while minimizing disruption to service.

(7) Condition Monitoring & Diagnostics: Diagnostic systems shall be used to detect, or where practicable, monitor the condition of the equipment, anticipate faults, and do need based proactive Predictive maintenance and to reduce requirements for periodic inspection Preventive maintenance, to reduce overall costs, and improve reliability.

(8) The Contractor shall submit system Reliability, Availability and Maintainability (RAM) Plan for review & approval of Engineer for complete Electric Traction System comprises of Traction Power Supply (TPS), Overhead Contact System (OCS), and Power SCADA.

14.2 RELIABILITY

Reliability Modelling

(1) The Contractor shall perform Reliability and Maintainability analyses of each system, up to the point of interface with other systems.

(2) The Contractor shall develop an evolving Reliability model consisting of Reliability Block Diagrams and probability of success equations. This model shall show the relationships required for system and equipment to operate successfully. The reliability block diagrams shall include all elements essential to the successful performance of the system and the interrelationships and interface of these elements. The model shall not reflect the degraded mode of operation. The Contractor shall revise the model to keep current with design iterations.

(3) The reliability model consisting of reliability block diagrams and probability of success equations shall be developed and submitted to the Employer for acceptance.

(4) Reliability apportionment and prediction analysis shall be in accordance with

established techniques or standards, or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

(5) The Reliability apportionment and prediction analysis shall be carried out in parallel with the design of the system. The relevant apportionment and prediction figures shall be part of the design submission documents for the individual equipment, sub-system and system.

Failure Definitions

(1) Failure: The inability to perform a required function, the occurrence of unexpected action by the equipment, or the degradation of performance to below the required specifications shall constitute a failure.

(2) Relevant Failure: A relevant failure of an item is an independent failure which results in a loss of function of that item caused by any of the following:

* A fault in an equipment or sub-system while operating within its design and environmental specification limits;

* Improper operation, maintenance, or testing of the item as a result of the Contractor supplied documentation.

* Failures of transient nature including those with post investigation status as 'No fault found', shall be considered as relevant failure if in the opinion of the Employer these are attributable to Electric Traction System.

(3) Non-relevant Failure: Any failure of an item not included in the definition of relevant failure, such as the following:

* A failure caused by malfunction of other equipment or sub-system that are not supplied by the Contractor;

* A failure caused by human error, except as noted in Relevant Failure above;

* A failure caused by accidents not associated with the normal operation of the item;

* A failure caused by operating the equipment or sub-system outside of design or environmental specification limits;

(4) Service Failure: Any relevant failure or combination of relevant failures during revenue service operations to determine availability for revenue service, which results in one of the following:

* Delay to train service;

* Fault preventing a train from entering service at its scheduled time;

(5) Pattern Failure: The repeated occurrences of 3 or more relevant failures of the same replaceable part, item or equipment in same manner in identical or equivalent applications when they occur at a rate which is inconsistent with the predicted failure rate of the part, item or equipment will be termed as pattern failure.

Reliability Requirements

(1) Reliability requirements and goals shall be developed in terms of Mean Time Between Service Failures (MTBSAF).

(2) The reliability requirement is subsidiary to the Availability and Maintainability requirements as specified in this PS.

(3) The Electric Traction System shall be fault tolerant such that the loss of functionality under failure conditions is minimized and that the system, where practicable, degrades gracefully and either continues to perform its required duty unaffected by failed elements.

(4) Redundant equipment/module/component shall change seamlessly when active part fails. If changeover has a finite time, contractor shall show that its system shall not obstruct the train operation.

(5) The system design shall ensure that the subsystems providing redundancy for failures are truly independent to minimize the risk of common mode faults.

(6) The Traction Power Supply (TPS) shall be designed such that any single key components may fail without impact on the operational performance of the overall Electric Traction system. This shall be demonstrated by calculation of the load flow in case of outage of critical main components, e.g. main traction transformer.

(7) All consumable and/or bought-out items shall have a high level of reliability, in particular where they shall remain continuously energized and in service e.g. insulators under tensile or compressive condition..

(8) The Electric Traction system shall be able to be operated independently from Power SCADA. In event that the SCADA system fails then the traction power and its protection system shall continue to operate autonomously, until either the SCADA system comes on line or until the switching station is placed into local control.

(9) The Contractor shall select the Equipment & components to achieve the required level of Reliability, Availability and Maintainability with highest MTBSAF matching with Industry benchmarks if any for approval of the Engineer.

Reliability Demonstration

(1) During the RAM demonstration phase, the Contractor shall collect and maintain data on every failure along with the data indicating the probable failure. MTBFshall be calculated throughout the monitoring period. The Contractor shall submit monthly Reliability Demonstration Reports.

(2) In case the Contractor is not able to achieve specified/predicted reliability target, the Contractor shall take necessary corrective measures either by way of change of design and/or replacement of the relevant equipment / component, at no additional cost to the Employer.

(3) The Contractor shall analyse each and every failure/ defect of components of various equipment to determine the cause of failure and propose corrective measures, which would be reviewed by the Employer.

(4) The high voltage circuit breakers, supply transformers, traction transformers, auxiliary transformers, interrupters, and AC cable (1000 Meters) have to be demonstrated for reliability as planned.

Reliability assessment

A Risk & failure study shall be performed for the various Sub-Systems, identifying the failure modes for each which contributes to reliability of the system and quantitative estimates prepared of the likelihood of failure. The system and the components shall comply with EN 50126/IEC 62278.

(1) The Contractor shall demonstrate the reliability of the proposed design and material for OHE equipment within the HORC operating environment of Prithla – New

Harsana Kalan section.

(2) For all critical items of the equipment offered the Contractor shall state the **Mean Time between Failure (MTBF)**, the Mean Time to Restore (MTTR), and details of preventative maintenance required to maintain full operational performance.

(3) Where equipment has novel features or where insufficient operational data is available, the Contractor shall state the methods used to determine reliability performance.

(4) All consumable and/or bought-out items shall have a high level of reliability in particular where they shall remain continuously energized and in service e.g. insulators.

(5) Reliability criteria of Traction Power Supply System shall be as per class in table below

Reliability Class	Description (Service affecting Failure)	Reliability Class Criteria (Failures per annum)
R1	Delay to train services exceeding 12 minutes, or fault preventing a train from entering service at its scheduled time.	35
R2	Delay to train services exceeding 30 minutes	10
R3	Delay to train services exceeding 60 minutes or closure of a crossing station for more than 2 hours, or implementation of single line working for a period of one hour or more.	0.667
R4	Severe service disruption resulting in trains being stranded on track for more than two hours or closure of a crossing station for more than one day	0.333
TOTAL		**46**

14.3 AVAILABILITY

(1) The Contractor shall be responsible for providing a System design, maintenance procedures, and defining the recommended spares holdings to ensure that the Availability requirements of the system shall be achieved.

(2) Availability shall be assessed by the calculated as follows:

$$Availability = \frac{MTBSAF}{(MTBSAF + MTTR)} \; x \; 100\%$$

Where:

:

(i) MTBSAF = Mean Time Between Service Affecting Failures.

(ii) MTTR = Mean Time to Restore

(3) The Contractor shall submit calculations with reliability block diagrams for each sub-system till LRU level to demonstrate the compliance with specified availability figures. The availability calculation shall take all possible failure modes into consideration that cause gap in service operation of system, subsystem, equipment or part thereof. The calculation shall be based on the Contractor's submitted equipment MTBSAF and MTTR data and the configuration of each sub-system.

(4) The overhead contact system design, arrangement and component design shall be chosen to ensure that the HORC shall have high service availability.

(5) The OHE design shall have mechanical independence of support for main line & where practicable for other lines. Adequate clearances shall be considered for designing to eliminate the chances of known short time interruptions due to Bird electrocution/ faults.

(6) The arrangement of tension lengths and wire runs shall minimize the effect of overhead equipment damage in a station or crossover on neighboring sections, in the event of overhead contact or catenary wire failure.

(7) TSS, SSP, SP, SS and ATS if any, shall be designed to a 100% availability level of N-1(First failure).

(8) Circuit breakers are provided to operate on definite fault or over current conditions, and should isolate only the faulty section/ part or equipment of OHE and Power supply system ensuring healthy system is not affected.

(9) Error detection and correction mechanism shall be included in the communication links as appropriate depending on the nature and functional criticality of the data conveyed.

(10) Switchover between redundant equipment, or between redundant routings, shall occur automatically and immediately upon failure and shall be transparent to the users. Toggling in switchovers shall be prevented.

(11) The Over Head Equipment (OHE) design shall have mechanical independence of support for main line & where practicable for other lines.

(12) The complete SCADA system shall be designed to meet 99.99% hardware availability. The OCC equipment shall have 100% redundancy. All OCC equipment shall be supplied power from two independent sources of supply.

(13) The OHE & ROCS shall have Availability better than 99.5% and Traction Power Supply sub-system better than 99%.

(14) Degraded performance or loss of any software or hardware dependent function of any end equipment shall be taken as unavailability.

(15) The contractor shall assume in the calculations that the service operating hours are 20 hours per day (00:00 to 10:00) and 14.00hrs to 24.00hrs.for 365 days in a year or as decided by the Engineer.

(16) It shall be possible to automatically re-energize the overhead line immediately following the occurrence of transient faults such as lightning, or bird strike causing a momentary short circuit. The auto-enclosure shall be of one shot only.

(17) Save and except where specifically approved, failures of the overhead line, or support equipment shall not cause loss of traction supply to more than one line. Provision shall be made, through section isolators/ interrupters/ Circuit breakers and other means, to allow reconfiguration of the traction power supply to feed the overhead line in areas not directly affected by the fault.

(18) Mechanical joints of conductors, which may be susceptible to failure, shall, where practicable, not be located in close proximity to locations where there is an interface where the public have access. e.g. Adjacent Indian Railways Stations and level crossings. Locations where the public have reasonable access may beinspected by the Engineer prior to Energisation of the electrical section.

(19) Availability Demonstration

i. The Contractor shall demonstrate the specified Availability during Service Trials and during the DNP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

ii. The demonstration test measure for Availability shall consider the performance of the Contractor's installed equipment, and the effectiveness of maintenance procedures recommended by the Contractor.

iii. The availability shall be worked out on the basis of the formula given during the preceding six months. In the event that the availability target as specified is not achieved, the Contractor shall,

(a) The determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

(b) The contractor at his own expense, will take action deemednecessary to meet the availability requirement.

14.4 MAINTAINABILITY

(1) Maintainability requirements and goals shall be developed in terms of Mean Time to Restore (MTTR) for all sub systems.

(2) The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including software re-boot, up to the point the system is restored to full functionality. In the event that the failure cannot be rectified, the measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functional module.

(3) The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

(4) Quantitative Maintainability assessments to all significant functional levels of the system, subsystems or equipment shall be allocated. Maintainability analyses during engineering, development and testing shall be used to evaluate the degree of achievement of the maintainability requirements. The Contractor shall identify the standards by which these allocations are made.

(5) The System shall be suitably designed to minimize the need for frequent preventive maintenance.

(6) Built-in self-diagnostics, power-up self-test and sufficient test points shall be provided in the System to minimize the time required to locate a fault. In addition,

especially the OHE & ROCS System and the associated traction power cable network shall be so arranged that the corrective maintenance work can be easily carried out under accidental crippled operation.

(7) All components, material, software and supports required for repair and servicing of the System shall be available during the entire lifetime of the System.

(8) The system shall maximize the use of remote means to conduct maintenance, fault finding and fault rectification activities and to access maintenanceinformation.

(9) The Contractor shall select the Equipment & components to achieve the required level of Reliability, Availability and Maintainability with least MTTR matching with Industry benchmarks, if any, for approval of the Engineer.

(10) The Power SCADA shall have an MTTR of less than 30 minutes. The Overhead Contact System shall have an MTTR less than 4 hours.

(11) The Contractor shall identify and Describe/document the maintenance requirement for the overhead contact equipment.

(12) The maintenance commitment in terms of frequency, number of personnel and specialist equipment shall be worked out by the contractor.

(13) OHE maintenance in terms of quantum of work and its frequency, number of personnel, varieties of types and number of specialist items and spares, shall be minimum.

(14) Repair facilities shall be provided to optimize speedy corrective maintenance by employing automatic diagnostics, test points etc. In addition, especially the OHE System and the associated traction power cable network shall be so arranged that the corrective maintenance work can be easily carried out under accidental crippled operation.

(15) All OHE components including tensioning devices shall be installed with sufficient lubrication to prevent mechanical failure in service.

(16) Maintainability Demonstration

i. The Contractor shall carry out tests to demonstrate that all maintainability predictions provided are met.

ii. The maintainability demonstration shall consist of simulated failures and repair activities, the duration of which shall be measured to determine the MTTR. As an alternative, data from actual maintenance actions for relevant independent failures occurring during the testing period may be used in lieu of simulation.

iii. A minimum of 50 maintenance actions shall be included for this demonstration.

iv. The maintenance actions shall be distributed among the equipment of each test group in proportion to their expected failure occurrence and in accordance with the MTBF.

v. In the event that any maintainability target is not achieved, the Contractor shall at his own expense take whatever action is deemed necessary to meet the maintainability targets.

vi. The Contractor shall ensure that all the required information including the related Maintenance Work Instructions (MWI) etc. is available to enable him to demonstrate the maintainability targets.

14.5 SAFETY

14.5.1 General

(1) Safety is defined as freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property, or withdraw the train from service, which is considered as a risk in all circumstances susceptible to cause injuries or person death (passengers, operation staff, maintenance staff), and/ or by extension all events leading to a partial or total destruction of costly equipment.

(2) The contractor shall be fully responsible for the system safety through the application of engineering and management principles, criteria and techniques to optimize all aspects of safety throughout all phases of the System life cycle.

(3) During consideration of precedence in the control of system hazards, the Contractor shall take account of human limitations as an engineering constraint. The Contractor shall take actions to satisfy requirements in the following order of precedence:

(a) Incorporation of fail-safe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and,

(b) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components

(4) Items relating to safety, contained within this Design Criteria and Standards, do not necessarily cover the full safety requirements.

(5) The Contractor shall be responsible for addressing all of the issues relating to safety, compliant with Indian Railway safety regulations.

(6) The design, construction, maintenance and monitoring of safety critical items, must be such as to guarantee safety at a level determined by the Contractor and presented to the Engineer for approval.

14.5.2 Safety Requirements

During each stage in the design and development process, the Contractor shall take cognizance of any hazard that arise as a result of the design or operation of the proposed equipment and take immediate steps to change the design or operation principals of the proposed equipment to mitigate the hazard.

All safety hazards shall be mitigated at the design stage where practicable.

(1) The installation design shall incorporate measures to avoid presenting safety hazards.

(2) The Systems design shall incorporate measures to provide for its safe management and operation.

(3) The Systems shall not give rise, or be subject to, dangerous interactions within the railway/DFCCIL or with other systems. Particular attention shall be paid by the Contractorto the interface with the adjacent Indian Railways infrastructure.

(4) The operation and maintenance of equipment inside the TSS, SP, SSP and SS shall satisfy the safety rules and system operation requirements of state power company.

(5) The system shall have fail-safe features. The Contractor shall incorporate the

SCADA earthing design requirements in the earthing and bonding management plan and design as described in this Particular Specification conforming to EN 50122-1.

(6) The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensure that the safety device does not introduce an additional hazard or system malfunction.

(7) The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder. The Contractor shall recommend special equipment operating procedures to reduce the probability of a hazardous event. All automatic/ manual switchover between Main and Standby equipment shall be seamless and shall not affect the normal and emergency operation of the system.

(8) The Traction installation shall meet the fire safety requirements as per Indian Electricity Rule and National Building Code etc.

(9) The design of the earthing system shall conform to IS 3043: 1987 (including latest amendments) and EN 50122-1, EN 50522, CBIP and IEEE-80:2013 as applicable to different parts of system.

14.5.3 System Safety Plan

(1) The Contractor shall develop a System Safety Plan as an integral part of the design which shall be reviewed / approved by The Engineer.

(2) The Plan shall address the general safety aspects associated with the OHE & ROCS designand peripheral features.

(3) The Plan shall include, Hazard Operability Studies (HAZOP) and Fault Tree Analysis (FTA) which shall fall into the following three categories:

(a) Subsystem hazard analysis (SSHA).

(b) Interface hazard analysis (IHA).

(c) Operating and support hazard analysis (O & SHA).

(d) Each of the above shall identify four degrees of risk:

(i) Catastrophic.

(ii) Critical.

(iii) Marginal.

(iv) Negligible.

(e) The above items related to safety do not necessarily cover the full requirements.

(f) It is the Contractor's responsibility to address all aspects of safety andcomply with legislation.

(g) The contractor should indicate mitigation measures for each hazard to keep the impact as low as reasonably practical (ALARP).

14.5.4 Quantified Risk Assessment

(1) The Contractor shall prepare a Quantified Risk Assessment (QRA) to model the risk

to:

(a) public

(b) maintenance and operations staff

(c) Public and staff on the adjacent Indian Railways Line and other third party infrastructure.

(2) The QRA shall address the risk of electrocution from the OHE and other equipment. For maintenance personnel key elements of the QRA shall include as a minimum an assessment of the risk of being struck by a train while working line- side, falls during maintenance, electrocution or injury due to crossing into Indian Railways territory. Accidental charging of dead section due to problem with SCADA and or due to other reasons and Interlocking posing safety hazard shall also be addressed.

(3) The Contractor shall demonstrate that the Systems have been designed to minimize the risk due to operator and maintainer error, considering both the ergonomic aspects of the System design to reduce the likelihood of error, and protective measures are adopted to mitigate the consequence of such error.

(4) The Contractor shall demonstrate that risk to public, including trespassers is as low as reasonably practicable.

(5) The contractor should indicate mitigation measures for each hazard to keep the impact as low as reasonably practical (ALARP).

14.5.5 Risks on Functional Safety

(1) The risks on functional safety System will include, but not be limited to, the following items:-

(a) Explosion or fire at TSS, SSP, ATS (if any), SP, SS and SCADA equipment room;

(b) Equipment safety;

(c) Damage to overhead conductors;

(d) Damage to overhead current collection system equipment;

(e) Damage to 25kV feeder and return cables;

(f) Electrical safety including safety clearance from exposed live conductors;

(g) Safety of the Engineer's staff and public, including trespassers as far as is reasonably practicable.

(h) Occupational repetitive injuries.

(2) The Contractor shall minimize the above-mentioned risks to a level as low as reasonably practicable in the design and construction stages of System.

(3) The contractor should indicate mitigation measures for each hazard to keep the impact as low as reasonably practical (ALARP).

14.5.6 Minimum Factors of Safety

(1) The mechanical design of OHE, contact wire, catenary wire, ROCS and other conductors shall take into account the permissible tensile stress, maximum temperature, allowable wear, wind loads, efficiency of tensioning devices, termination fittings, welded or soldered joints, additional vertical load in accordance with EN 50119 to allow adequate factor of safety under all conditions.

(2) Structures and SPS, in combined tension/compression and bending, shall have

safety factors in compliance with the appropriate design codes.

14.5.7 Hazard Log

A Hazard Log shall be established as a basis for on-going risk management. The hazard Log shall be updated with each event identified and mitigated. Residual Risk shall be carried forward and rules and procedures proposed to the Employer for the Management of such Residual Risk.

14.5.8 Hazard Analysis

(1) The Contractor shall, as part of the safety analysis, prepare analysis to identify Hazards and ensure their satisfactory resolution. The following analysis shall be prepared and submitted by the Contractor for the Employer's acceptance:

(a) Preliminary Hazard Analysis (PHA)

(b) Subsystem Hazard Analysis (SSHA)

(c) Interface Hazard Analysis (IHA)

(d) Operating and Support Hazard Analysis (O&SHA)

(e) Quantitative Fault Tree Analysis (QFTA)

(f) Failure Modes, Effects and Criticality Analysis (FMECA)

(2) The Contractor shall carryout the Hazard Analysis and FMECA/FTA for key equipment / sub-systems / systems. As a result of hazard analysis, the Contractor shall:

(a) Identify and list the hazards

(b) Identify and list the Safety Requirement Specifications

(c) Identify and list the safety related functions

(d) Specify for each safety related function the safety related failures

(e) Identify and list the safety critical and non-safety critical items.

(3) The hazard analysis shall address the risk of electrocution from the OHE, ROCS and otherequipment. For maintenance personnel key elements shall include, as a minimum, an assessment of the risk of being struck by a train while working line-side, falls during maintenance, electrocution or injury due to crossing into Indian Railways territory. Accidental charging of dead section due to problem with SCADA and or due to other reasons and Interlocking posing safety hazard shall also be addressed.

(4) The functional safety risk analysis translating to category of Hazards will include but not limited to the following:-

(a) Explosion or fire at TSS, SP , SSP, ATS (if any), SS, and SCADA

(b) equipment room;

(c) Equipment safety;

(d) Damage to overhead conductors;

(e) Damage to overhead current collection system equipment;

(f) Damage to 25kV feeder and return cables;

(g) Electrical safety including safety clearance from exposed live conductors;

(h) Safety of the Engineer's staff and public, including trespassers as far as is reasonably practicable.

(i) Occupational repetitive injuries.

(5) The Hazard Review Procedure shall be submitted for the Employer's approval. The final risk assessment, acceptance of mitigation and close out of hazards shall conform to the approved safety and risk acceptance criteria.

(6) The following targets/norms shall be employed for the Fault Tree Analysis. These norms are subject to review by the Engineer during the detailed design stage, and mutually agreed upon:

(a) No single point failure shall lead to fatality.

(b) No combination of undetected failure and double point failures shall result in fatality.

(c) No combination of undetected failure and single point failure shall result in major injury.

(7) The Hazard Log shall be substantially complete prior to commencement of Trial Running and shall be handed over to the Engineer complete in all respects prior to the commencement of Revenue Service.

(8) The Contractor shall fully develop a Safety Critical Items List (SCIL) which shall be updated as required and carried forward throughout implementation until final resolution of identified hazards is achieved.

(9) The design, construction, maintenance and monitoring of safety critical items, must be such as to guarantee safety at a level determined by the Contractor and presented to the Engineer for approval.

(10) Further, the information presented by the Contractor shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the engineering program characteristics and behaviour.

(11) The procedures for Operation, Maintenance, Training and the Contractor Quality Assurance manuals shall incorporate resolution of hazards so identified from this Hazard Analysis. Proper cross-referencing to the hazards and resolution measures shall be provided in all these aforementioned documents.

14.5.9 Design/Systems Safety Studies and Report

The Design/Systems Safety Studies and a Report shall be submitted at the completion of the Detailed Design period to confirm that all safety related aspects of design have been properly addressed and comprehensively validated.

14.5.10 Engineering Safety Validation Plan and Report

(1) The Contractor shall submit Engineering Safety Validation Plan to demonstrate that the system has been designed to minimize the risk due to a hazard and protective measures have been adopted to mitigate the risk.

(2) The Engineering Safety Validation Plan will outline the safety related tests to be conducted during the on-site testing and integrated system testing phase. The document will include the validation of the safety requirements for the system. Throughout this document details test cases carried out in order to validate the system, the relationship of the effects found in these tests and the validation of the same in subsequent tests will ensure that the system comply with the safety requirements.

(3) The Contractor shall demonstrate that the sub-systems have been designed to

minimize the risk due to operator and maintainer error, considering both the ergonomic aspects of the System design to reduce the likelihood of error, and protective measures are adopted to mitigate the consequence of such error.

(4) An Engineering Safety Validation Report will be submitted after the completion of this testing.

14.5.11 Relational Database Management System

(1) All hazard resolution by procedural control shall be cross-referenced from the safety critical and non-safety critical Items List to the appropriate manuals. The results of the Hazard Analysis shall be recorded and maintained by the Contractor in a Hazard Log in the form of a relational database that can be used to track progress in the implementation of mitigating actions and control measures, and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard of any type in an any location for any area of activity. Proper cross-referencing to the hazards and resolution measures shall be provided in all these afore mentioned documents.

(2) The fully functional soft copy of the relational database management system shall include together with all passwords, supporting software and instructions on its use and further development during Revenue Service.

14.5.12 RAM Demonstration

(1) RAM Demonstration Plan

i. The Contractor shall submit RAM Demonstration Plan to the Engineer for approval before the final design review to demonstrate that all RAM predictions and specifications are met.

ii. The requirements relating to Maintainability shall be demonstrated before the commencement of Trial Running and may begin as soon as the necessary systems or elements of systems have been tested and commissioned.

iii. The requirements relating to Reliability and Availability shall be demonstrated throughout Trial Running Period and the Defects LiabilityPeriod.

(2) Failure Reporting and Corrective Action System (FRACAS)

i. The Contractor shall be required to establish a computer based Failure Reporting and Corrective Action System (FRACAS) during the RAM Demonstration phase. The FRACAS proposed by the contractor shall need the approval of the Employer.

ii. The FRACAS will:

(a) Provide a process for reporting, classifying, analyzing failures, and planning corrective actions in response to those failures.

(b) Collect data, record and analyse system failures.

(c) Produce a history of failure and corrective actions.

14.5.13 System Assurance Submissions

Deliverable Documents

The Contractor shall implement and submit system assurance supporting documents in accordance with the approved System Assurance Plan which shall include, but not be limited to, the following documents at the times indicated in the table below:

S No	Document Description	Plan Development Stage					Remarks
		Design Stage		Manufacture/Construction/Installation	Testing/ Trial Run Stage	Warranty Stage	
		PRELIM	FINAL				
1	System Assurance Plan (included System RAM Plan and System Safety Plan)	P					Shall be submitted within 56 days after the Commencement Date
2	System RAM Plan		U	U	U		
3	System Safety Plan		U	U	U		
4	Safety Policy	P					Shall be submitted within 56 days after the Commencement Date
5	Hazard Analysis and Hazard Log	P	U	U	U	U	First report shall be submitted within 28 days after the preliminary design completion. The report to include Safety Requirements Specifications and Safety Critical Item List (SCIL).
6	Design/ Safety Studies and Report		P	U	U		First report shall be submitted within 28 days after the final design completion. The report shall at least include the Safety Requirement

S No	Document Description	Plan Development Stage					Remarks
		Design Stage		Manufacture/Construction/Installation	Testing/ Trial Run Stage	Warranty Stage	
		PRELIM	FINAL				
							Specification, Hazard Log, Deterministic Safety Assessment, Quantitative Risk Assessment, Safety Integrity Level Analysis, Failure Mode, Effect and Criticality Analysis, Reliability Block Diagram
7	RAM Analysis and Prediction Report		**P**	**U**	**U**	**U**	First report shall be submitted within 28 days after the final design completion. Report will also include RCIL and MCIL.
8	FMECA		**P**	**U**	**U**	**U**	First report shall be submitted within 28 days after the final design completion
9	RAM Test / Demonstration Plan		**P**	**U**	**U**	**U**	First report shall be submitted within 28 days after the final design completion. The demonstration plan shall include the proposed FRACAS system.

10	RAM Test / Demonstration Report				**P**	**P**	- Reports shall be submitted separately within 28 days after each completion of demonstration tests in terms of maintainability demonstration test, and availability / reliability demonstration test. - Monthly RAM - Demonstration Records and Reports shall be submitted at the 7thday for prior month ending during Defect Notification Period
11	Engineering Safety Validation Plan		**P**	**U**	**U**		First report shall be submitted within 28 days after the final design completion
12	Engineering Safety Validation Report				**P**		Shall be submitted within 28 days after completion of safety validation test
13	Operational Safety Case	**P**			**P**		Second report shall be submitted within 28 days after the completion of safety validation test

P - Document Produce

U - Document Update

(End of Chapter 14)

CHAPTER 15 - SUPERVISION AND PLANNING OF MAINTENANCE

15.1 GENERAL

The requirements of supervision and planning of maintenance are to be complied as per Employer's Requirements, Part 2, Section VII-1, Chapter 14: Operation & Maintenance Spares, and Tools & Plants of General Specifications and as per specifications / provisions mentioned below:

15.2 SUPERVISORY STAFF

The Contractor shall provide Competent supervisory & maintenance staff in adequate numbers, having expertise in fault finding, maintenance &repair of the various systems supplied under the Contract for full time appropriately positioned to report at point of assembly/ depot, during any fault to attend during entire Defect notification period, as extended if any, covering at least the following areas of excellence:-

(1) Traction Substation including SSP, SP and ATS if any

(2) 2x25kV/1x25kV flexible OHE & ROCS system

(3) SCADA System

15.3 CONTRACTOR'S OFFICE DURING DEFECT NOTIFICATION PERIOD

Contractor shall establish and maintain the 'Maintenance office(s)' manned with the supervisory and maintenance staff with a Dedicated Desk Officer to attend the calls of the Employer's Personnel and inform their Head of Maintenance who would promptly act to attend the emergencies/ maintenance calls including organizing of all the resources i.e. artisans and Material.

The Contractor Shall Maintain a computer based FRACAS system to log all the events of Failure.

15.4 MAN & MATERIAL REQUIRED DURING DEFECT NOTIFICATION PERIOD

The contractor shall resource the required staff and Material during the Defect Notification period at their own cost 24 hrs all 7 days of every week to attend the Defects. The deployment of staff shall be approved by the Engineer. The Material, if any, used from the spares shall be made good. The contractor shall arrange all the Tools & Plants needed to attend the defects during the Defect Notification period.

The Contractor shall replace, the defective systems/sub-systems/ equipment /modules/items/parts during the Defect Notification Period (DNP). For this purpose, the Contractor shall store adequate number of equipment/modules/items/parts so that the defect is rectified in the least possible time without adversely affecting the train operation.

(End of Chapter 15)

CHAPTER 16 – TRAINING

16.1 GENERAL REQUIREMENTS

The Contractor shall provide comprehensive training to the Employer's personnel in accordance with the requirements contained in this PS and as per Employer's Requirements, Part 2, Section VII-1 Chapter 13 — Training & Transfer of Technology of General Specifications and as per specifications / provisions mentioned below:

16.2 TRAINING PLAN

The training plans shall be developed as per provisions in the General Specifications and submitted to Engineer for review and approval. The plan shall also include but not limited to the following:

16.2.1 The training shall be carried out at such locations where the greatest benefit for trainees may be gained .The training will include the Training/ exposure at OEM's Manufacturing Place to give the exposure / hands on experience to the technology, manufacturing process, assembly and quality & Test Checkpoints and sensitise the trainee on the quality and test procedures so that similar standards can be replicated at Place of Maintenance.

16.2.2 The Training Plan shall include training at site office/site as above and shall include 200 man-days as a minimum at OEM's Place. The plan shall also include visit to different places, work- areas plants. The cost of travel and stay shall be borne by the Employer. The training should also include 200 instructor man-days as minimum to impart training at work site.

16.2.3 The training plan should include subjects like Condition Based maintenance to reduce the down time of equipment/ system and maintenance cost. The plan should also cover the details of equipment/ instruments required for monitoring the condition / health of the equipment / system.

16.3 MOCK UP FOR TRAINING

16.3.1 The Contractor shall install mock up equipment for system and any such facility(s) considered necessary for the training of Employer's personnel.

16.3.2 The training mock up shall include but not limited to the following: -

(1) OHE & ROCS system components

(2) Contact, messenger/catenary, negative feeder wire and aerial earth wires;

(3) Section insulator;

(4) Jumper and cable connections to OHE;

(5) Rail bonds and cable rail connections of return circuits;

(6) Circuit breakers and Interrupters and their component assemblies;

(7) Isolators;

(8) SCADA training Aids such as RTU, PCU and OCC.

(9) Cut Sections of Circuit breakers, interrupters, cables

(10) Cut sections of Gas Insulated switchgear

(11) Clear photographs of various equipment such as transformers, their windings,

rectifier and inverter sets;

(12) Samples of various clamps and fittings used;

(13) Control panel, protection schemes, earthing and bonding arrangement;

16.4 TRAINING OF EMPLOYER'S TRAINING INSTRUCTORS (ETI)

16.4.1 The Contractor shall provide training to the Employer's Training Instructors on the various Systems. Aspects covered shall include, but not be limited to, the following:

(1) Configuration of the entire System, including interface with Indian Railway linking OHE system and boundary location SCADA control;

(2) Feature and functional principles of the entire System;

(3) System design aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, Insulation and protection co-ordination;

(4) Details of major equipment and material including but not limited to 220/132 kV, 25kV, circuit breakers, interrupters, isolators, voltage and current transformers, OHE/ROCS conductors, fittings, assemblies and protection relays, batteries and chargers, and cables of different types and their joints used in the System;

(5) System operation and maintenance management and procedures;

(6) SCADA System; and

(7) Earthing and bonding arrangement, covering safety aspects of touch and step potential safety to personnel, passengers and outsiders.

16.5 OPERATIONS STAFF TRAINING

16.5.1 The objective of the training is to enable the Employer's operations staff to be familiar with the Systems, with focus on the operational aspects under normal and emergency conditions.

16.5.2 The training shall also enable the trainee to acquire full capability for identification, trouble shooting and rectification of faults in the specified duration. After classroom training which includes mock-up of equipment, the staff shall be trained in actual operation.

16.6 COMPUTER BASED TRAINING (CBT)

16.6.1 The Contractor shall submit, for the Engineer's review, the following CBT information documents:

(1) Operation of the TSS, SSP and SP power Systems;

(2) Maintenance of TSS, SSP and SP power Systems;

(3) Operation of OHE including return feeder System;

(4) Maintenance of OHE & ROCS including return feeder System.

(5) Operation of SCADA System;

(6) Maintenance of SCADA System.

(7) Boundary post SCADA operation by HORC/IR/DFCCIL.

16.6.2 The CBT Information Document on Operation of individual System shall contain, but not be limited to, the following:

(1) General introduction of the System, its functionalities and objectives (including the RAMS requirement);

(2) Single line diagrams;

(3) Description of the System operation principles, for both normal and emergency operation conditions;

(4) An overview on the System configuration, including interface with other agencies;

(5) General description of the functions of each key equipment and components of the System with photographs showing the appearance of each of them, where they (Key equipment and components) are located throughout the HORC;

(6) List of potential hazards that may arise in operating the System;

(7) Any specific points to note in operating the System to ensure safety to personnel (the Employer's staff and members of the public) and equipment, and;

(8) Electric shock treatment.

16.6.3 The CBT Information Document on Maintenance of individual System shall contain, but not be limited to, the following:

(1) General description of the functions of key components of the System, with photographs showing the appearance of each of them;

(2) A general description of the proposed maintenance strategy of the System and major components;

(3) The maintenance plan and procedures proposed for the System and major components in accordance with the MMS;

(4) CBT as per the levels of maintenance activities required for the System and major components.

(5) An introduction to the special tools and equipment required for maintaining the System and major components;

(6) Tests to be conducted after maintenance and the test equipment required.

(7) A description of the symptoms of the common faults found on the System;

(8) Simulation of faults on the entire System, and how to promptly restore the system; and

(9) Other points to be noted in effectively maintaining the System.

16.7 TRAINING AND TRANSFER OF SKILLS

16.7.1 The training shall broadly cover the following aspects:

(1) Flexible OHE & ROCS;

(2) SCADA System;

(3) Protection and Control;

(4) Gas Insulated Switchgear, if used

(5) Traction Power Supply equipment.

16.7.2 After training the personnel should achieve satisfactory skills and capabilities as under but not limited to:

(1) Identification of various cards and components of RTU

(2) Erection, wiring and commissioning of RTUs and troubleshooting of RTUs

(3) Configuration of addresses of RTUs, future expansion and setting up of additional tele-commands, tele-signals.

(4) Using the test instruments to check the communication cable performance parameters

(5) Operation & maintenance instructions recommended by OEMs of different SCADA subsystems.

(6) Skills in special aspects of repair and maintenance of Traction Transformers and Auto- transformers.

(7) Skills in special aspects of repair and maintenance of installed equipment of 220/132kV, 2x25kV and 25 kV switchgear etc.

16.7.3 Methods of Training shall include Class room training, audio visual aids, mock up, samples, site visits to OEM's Place, and/or places of Installation where such equipment and components are used by any other client of the vendor/ Manufacturer.

(End of Chapter 16)

CHAPTER 17 - OPERATION AND MAINTENANCE DOCUMENTATION

17.1 GENERAL

17.1.1 The Contractor shall provide Operation and Maintenance documentation as per Employer's Requirements, Part 2, Section VI, Vol-1, Chapter 14 — Operation & Maintenance, Spares , Tools & Plants of General Specifications.

17.1.2 Operation and Maintenance & other Manuals for Installed system to provide all necessary information on traction power supply, all equipment from 220/132 kV TSS incomer/traction substations, through 25kV AT Feeding System and Over Head contact line Equipment (OHE) system, complete with a central supervisory control and data acquisition system (SCADA) for Monitoring & Control of Pirthla – New Harsana Kalan section of HORC but not limited to:

(i) System configuration/ scheme and major subsystems & components,

(ii) System Architecture and Redundancies,

(iii) Contingency Scenarios and Mitigation Measures,

(iv) Performance Parameters for stringent application duty scenario,

(v) Monitoring, Control and Protection system,

(vi) Environmental and Operational Parameters for the Electric Traction system,

(vii) Reliability, Availability, Maintainability and Safety benchmark, Performance Parameters benchmarks including compliance and demonstrations at design and operational stage,

(viii) Design & Drawings,

(ix) Producing Combined Service Drawings (CSD) and Interface with the high voltage network of the Indian Railway , and with the associate sub-systems such as rolling stock, train control system, signalling, communications, operations and maintenance requirements, track form, track alignment, depot and station layouts and civil infrastructure,

(x) Site execution requirements including Safety, Health, environment Construction Machinery and Methods; Gadgets, Wiring Trains and Inspection Cars and Testing & Commissioning,

(xi) Procedures and Statutory Approvals.

(End of Chapter 17

CHAPTER 18 - INTERFACE MANAGEMENT

18.1 GENERAL

18.1.1 This chapter outlines the Contractor's interface requirements between Contractors (SYS-1), other designated Civil Contractor (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1), termed as CST Contractors; Signalling and Telecommunication Contractor SYS-2 and Electrical (OHE) Contractor MSIL(OHE), Indian Railways, DFCCIL, State Electricity Authorities and State regulation authorities etc. The details of all Contractors i.e Civil, S&T and Electrical are given in clause 2.3 of PS.

18.1.2 The Contractor shall maintain a close interface with relevant authorities, Contractors and agencies to ensure the time bound completion of this project and to ensure that all requirements of the General Specifications and Particular Specification pertaining to interface are fully resolved and implemented.

18.1.3 The Interface as described in this document is for reference only. It is the Contractor's responsibility to develop, update and execute jointly an "Interface Management Plan" for defining responsibilities and to exchange information in order to achieve/comply the interface requirements before the commencement of the Work and throughout the execution of the Project work to ensure that:

(1) All interface issues between the Contractors are satisfactorily resolved;

(2) Supply, installation testing & commissioning, operation and maintenance of equipment are fully coordinated; and

(3) All equipment and facilities supplied under the Contracts are fully compatible and integrated with each other, whilst meeting the requirements of the respective Specifications.

18.2 OBJECTIVE

18.2.1 The design and construction of new HORC lines is a complex multi- disciplinary project, requiring close interaction and co-ordination between the various Contractors.

18.2.2 An 'Interface Matrix' is developed to define the interface requirements and demarcate the jurisdiction. The objective of the "Interface Matrix" is to identify the activities of scope of work to avoid conflict amongst different contractors, which could possibly minimise and facilitate hassle free execution of works.

18.2.3 This document outlines the interfacing requirement during the execution of the works. However, the requirements herein specified are by no means exhaustive and it remains Contractors' responsibilities to develop and execute jointly an interface management plan throughout the execution of works to ensure that:

a. All interface issues between 2x25kV, AC Traction Electrification, E&M and Civil Works Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1), Signalling and Telecommunication Contractor SYS-2 and Electrical (OHE) Contractor MSIL(OHE) and Other Designated Contractors are satisfactorily identified and resolved.

b. All the Construction tolerances at the interface shall meet the requirements of the respective specification,

18.2.4 This "Interface Matrix" shall be read in conjunction with the relevant provisions of the Contract Specifications. The 'Contractor (SYS-1) and the other Interfacing Contractors shall be responsible for compliance of all requirement of the Specification in terms of the defined scope of work of the Parties.

18.2.5 Notwithstanding the requirements described elsewhere in the contract regarding the precedence of document, the provision contained in the drawings and elsewhere in the particular specifications shall prevail over the provisions contained in this Interface Matrix.

18.2.6 Interface requirement for access to works for provision of Traction power supply and 2x25 kV, AC OHE works involving space for traction structures along the tracks, on bridges / viaducts for OHE, Location of signals, as well as of switching off locomotives at neutral sections and finally system proving tests etc shall be resolved.

18.2.7 The Employer/Engineer shall organize coordination meetings to resolve all interfacing issues amongst the Contractors. In addition, the system wise Contractor may also arrange his own coordination meetings with the Other Contractors.

18.3 INTERFACING REQUIREMENTS

18.3.1 The following is an indicative list of the Contractors with whom the Contractor (SYS-1) shall essentially interface. The List is not, however, exhaustive and the System Works Contractor (SYS-1) shall ensure that any site problem, as and when it arises, is clearly and conclusively discussed with the appropriate Agency and solutions arrived at.

1) Civil, Building, tunnel and Track Work Contractors;

2) Contractors of adjacent section i.e IR and DFCCIL, if any.

18.3.2 In addition, the Contractor (SYS-1) is also required to interface with the,

1) Indian Railways (Northern Railway)

2) Power Supply Authorities: Indian Railway and State Power Supply Authorities / Distribution Companies,

3) Statutory bodies like local civil authorities, public utility companies, and

4) Those who are considered to be related with the work.

18.4 INTERFACE

18.4.1 INTERFACE WITH CIVIL, BUILDING, TUNNEL & TRACK CONTRACTORS

1) ITEMS OF INTERFACE

The System Works Contractor (SYS-1) shall be responsible for the design, procurement, delivery at site, installation, testing, commissioning, support, operation and maintenance, and setting to work for Overhead Electric Traction System and related wayside switching station equipment and facilities.

Interfacing with Civil, Structure, Tunnel and Track contractors will be required for -

a) Information regarding track alignment, cant, versine, track geometry, rail levels, gradient, curve details, track center along with transition curve details.

b) Access to site on main line, traction substations (TSS), switching stations (SSP/SP), Auto Transformers, Isolators, Interrupters etc.

c) Path, access road to site.

d) The System Contractor may please note that no movement of men and material will be permitted on the embankment unless and until the blanket layer upto the designed thickness is finished.

e) Access & ROW of Rail Track to facilitate movement of Material train and Tower Wagon to finish Wiring & adjustments of the conductors.

f) Earthing & Bonding connections between AEW, Masts, Rails, all non- current carrying structures including BEC (if required) as per the Schematic attached.

g) Providing earth continuity in reinforcement bars of girder /concrete bridge and earth terminals at either ends on end sections.

h) Providing HDPE/ GI pipes below tracks of requisite size for track-crossing by traction cables.

i) Providing continuity bonds in track, particularly at points and crossings.

2) Information Exchange

The System contractor (SYS-1) shall exchange all the information with the Civil contractors regarding the information on the Traction Power Return System (TPRS) and the Traction Power Distribution System (TPDS) i.e. OHE/ROCS and its supports and the sequence of the execution. The Details shared shall be read in conjunctionwith the Technical Specifications shared by the Contractor (SYS-1).

3) Interface requirements

The Interface requirements are described in Table-18.4.1

Table-18.4.1

Interfacing Requirement with Civil, Building and Track Work Contractor (CST)

Item No.	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
1.	Information exchange on alignment with following details: a) Track Formation Crosssection b) Track alignment Drawing c) GPS coordinates of trackCentre d) Curves e) gradient f) Rail levels, g) Storm water & natural drainage etc. h) Track layout	Based on the information of track geometry received from Civil Contractors : - Shall carry out detailed survey and verify the alignment drawings, Centre line, cross sections, track geometry at mainline and junction station yards, and advise the respondent regarding infringements and modifications if any, - Shall develop Traction System Design & drawings /diagrams with consideration to the data shared by Civil contractors. - Shall prepare General Arrangement Drawing (GAD) and layout plans for traction supply installations and OHE/ROCS of main line Junction / crossing stations, yard and siding including finalization of the Foundation Design & Drawings.	Shall provide final Track alignment drawings & plans, details of track geometry /structure, curves, gradients and Rail levels etc. alongwith details on storm water drains for the mainlines, crossing / junction stations and tunnel data. Shall share with System Contractor (SYS-1), the GPS coordinates of Centre lines of tracks as finalized and approved by the Engineer and mark the track centre as well as track level to facilitate the OHE design & Foundation casting by contractor (SYS-1). Shall share track work design details with System Contractor (SYS-1). Shall share the information with the System Contractor (SYS-1) within the specified schedule to achieve the targeted Milestone.	All locations throughout the Alignment

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
2	Completion of Track activities essential for commencement of Physical work at site for each section a) Finishing of Blanket layer b) Completion of Track fit for movement of Tower wagon, Mechanized wiring Train and Material Train to Transport masts etc. c) Track connectivity Mechanized wiring Train stabling andTower wagon shed d) Completion of Tower wagon shed, e) Final Fitness of Track for SED checks	Shall Coordinate with the CST contractorand shall maintain a coordinator to continuous liaise with them, conduct meetings and seek information and keepthe Engineer informed regarding completionof Blanket layer, Track fit for movement of Tower Wagon, Mechanized wiring Train and Material Train, stabling lines and Plan for Construction activities as per the Delivery schedule Shall take the access to the Blanket layer, Rail track and stabling siding for execution of the work. Shall construct Tower Wagon shed Shall coordinate with Civil Contractors for track connectivity of Tower wagon shed and final fitness of track for SED	Shall share the works programme of and Date of Completion of following activities of various sections of continuous lengths of minimum 3 km to the Contractor (SYS-1) for System Works: (a) Finishing of blanketing layer. (b), (c), (d) & (e) Completion of track fit for movement of tower wagons, mechanized wiring trains and material trains the access of which shall generally be made available to the System Contractor by the Civil Contractors. Shall coordinate with Contractor (SYS-1). CST contractor shall hand over the work site in continuous lengths of minimum 3 km to Contractor SYS-1 as per access dates schedule.	Along the route,

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
3	Provision of OHE masts / anchors locations. Support bracket for ROCS in tunnel.	Shall issue 'the pegging plans' indicating the locations of OHE masts / anchors. Shall assess the Soil Bearing capacity, Moisture content and measure earth resistivity and improve the same if earth resistance exceeds 25 Ohms. Shall design & construct the foundation conforming the track bed profile without exposing any portion of the Foundation, covering and protecting unavoidable portions of Exposed foundations. Shall advise location of support bracket of ROCS for Anchor bolt grouting.	Shall advise about infringements to the Track alignments, anchoring limitations to the structures, restrictions to exposed foundations and advise for correction, if any. Shall share the embankment design Data. Shall share the tunnel data to Contractor (SYS-1) for erection of Anchor bolts for ROCS support bracket and NFW.	Mainline and sidings. Both Tunnels.
4.	Right of Way (ROW) and Access to site: a) main line, substations, switching stations SSP/SP, b) Junction/crossing stations, yards, temporary sidings and storage space along the route for construction activities.	Shall hold interface meetings to settle such locations & sizes, spaces for access route required /available as per site conditions for a) main line for movement of construction staff &Material, b) substations from Road and Tracks, c) switching stations SSP/SP or SS if any, d) Junction/crossing stations, yards, temporary sidings and storage space along the route.	Shall not temper the natural ground to be used by other contractor for their activities such as Construction of TSS, SSP, & SP. Shall not encroach/obstruct land or access routes earmarked for construction activities of other contractors as handed over by HORC or Civil contractor. Shall complete all the activities i.e. Blanket layer and Track laying etc. in coordination with the construction activities of System Contractor (SYS-1) to meet the timeline. Keep the space/ ROW earmarked for exclusive/ shared use for movement of Material to the construction site i.e. TSS, SSP, and SP, Junction/crossing stations, yards, temporary sidings and storage space along the route.	Main Line & sidings, Substations, Switching Stations, Junction and Crossing Stations and approach roads

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
5	Provision of approach road to the construction sites from Junction / Crossing stations	Shall coordinate with HRIDC and the relevant contractors for access routes to connect the construction sites with the nearest Junction/ Crossing stations/ available point and utilize as per the requirement including making fit for purpose. Shall use the ROW / access as earmarked for the use by the Engineer	Shall share the access routes with other contractors as approved by the Engineer.	All stations to TSS, SSP, SP
6.	Provision of GI/HDPE pipes below tracks for crossing of power cables across tracks at locations near substations, switching stations , Junction/crossing stations, yards	Shall provide schematic drawings showing specific locations, GI/HDPE Pipe sizes and number of pipes as required for cable crossing, across tracks to Civil Contractor generally conforming the Typical Schematics of Bid documents. Shall coordinate with Civil contractor and confirm suitability of locations and share all the information to facilitate laying of pipes / cables as per requirement.	Shall supply and provide the GI / HDPE pipes as required below track as per requirement for Cable Crossings etc. in coordination with System Contractor (SYS-1) and as approved by the Engineer.	Main Line, Substations, Switching Stations and Crossing Stations
7.	Provision of Buried Earth Conductor (BEC, if required) and Earthing & Bonding connections Longitudinal to the Alignment, Connections & terminals including crossing under the tracks	Shall supply and install (continuous) Buried Earth Conductor (BEC, if required) all along the alignment buried in soil within formation including crossing under the Track (wherever required) and brought out connections with terminals above ground. Shall provide connections/ extensions through welded lap joints/ exothermic joints as approved by The Engineer. Shall provide schematic drawings and	Shall allow the Cad-weld connections to the BEC (if required)/ terminals by the System Contractor (SYS-1). Shall allow installation of BEC (if required) as per method statement approved by the Engineer.	Main Line, Substations, Switching Stations and Crossing Stations

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
		designs showing profile/ size & Material Specifications of BEC (if required), Typical laying arrangement longitudinal to the alignment, brought out Connections above ground with terminals, crossing under the track including earthing & bonding Joints, connection with Rails. Shall coordinate with the Civil contractor so that the BEC (if required) is installed while the formation work is in the progress by the Civil Contractor and formation is not required to be excavated for laying of BEC (if required).		
8.	BEC (if required) connection to Rails	The System Contractor (SYS-1) shall share the information regarding the requirement of jointing with rails for connecting with BEC (if required) Terminals Generally the BEC (if required) connection to the rails shall be through Exothermic Joint. The System Contractor (SYS-1) shall share the information regarding the places where There is least possibility of making Exothermic joints and requesting for the Bolted Connections to allow the drilling of holes in Rails.	The Civil Contractor shall share the Technical specifications of Rail. Shall accommodate the requirement of Drilling of Holes in Rails/ Exothermic joints with Rails. Shall ensure availability of the supervising team to permit the drilling in rails including Exothermic joints including the guidance as may be essential to ensure least damages to the rails.	Mainline, Yards
9.	Earthing of metallic structure in parallelism with OHE	Shall Provide earthing & bonding of all metallic structures in parallel with OHE by means of two separate and distinct connections with BEC (if required). Shall interface and get all drawing and scheme signed by Employer's Engineer ascertaining adequacy of earthing and bonding requirements.	Shall provide drawings of fencing and other metallic structures running along the track for long distances. Shall coordinate with contractor (SYS-1) for making earth connection with metallic structures as per approved design/drawings	Main Line, Substations, Switching Stations and Crossing Stations

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
10.	Bridges (Concrete / Metallic) OHE Load on the Pier cap of bridges due to OHE Masts/Anchors etc.	Shall provide OHE Layout Plan (LOP) of proposed locations of OHE Masts and Anchor locations. Shall get approved from the Engineer; the schematic drawings and specification showing the arrangement of Holding Down Bolts (HDB) for OHE mast and anchor at Bridges Shall coordinate with Civil contractor and confirm for suitability and extend all assistance for making Holding Down Bolts (HDB) as per approved design/drawings. Shall also share values of Max direct load, Bending Moment, etc. arising due to the OHE Masts, fittings and anchors, which have to be considered in the design of Piers. Shall provide staff to witness the provisions made by the Civil contractor for adequacy and suitability. Shall amend the design & install the OHE system appropriately as per the provisions available on the bridges finally executed.	Shall take into account the OHE mast location, loads and bending moment etc. and ensure that the Pier Cap which are to receive the OHE Mast and Anchor etc. are suitable designed. Shall cater for the OHE provisions as approved by the Engineer. Shall supply and cast the necessary Holding Down Bolts in concrete as per approved scheme and design as approved by the Engineer. Shall ensure that the holding down bolts are not damaged until handed over to the System Contractor (SYS-1).	Bridges
11.	Electrical Clearances at Bridges (FOB, ROB) Over – Line Structures above tracks or OHE	Shall interface for infringements to SSOD if any and Electrical Clearances and required modifications / improvements. Update /modify traction OHE drawings based on the interface information. Shall interface and get all drawing and scheme signed from the Engineer ascertaining adequacy of electrical clearances as per approved design/drawings.	Shall supply list of Over – Line Structures (FOB & ROB) indicating specific locations, cross-sections, height above Rail level and dimensions details for evaluation of infringements, if any. Shall accommodate the requirement of the System Contractor (SYS-1) as approved by the Engineer.	Bridges

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors	Locations
12.	Earthing and bonding of over Line Structure -Bridges – Metallic (including FOB, ROB)	Shall provide schematic for Earthing & Bonding of bridge (metallic if any) with BEC (if required). Shall provide earthing of over line structures(metallic if any) with BEC (if required).	Shall provide necessary terminal plate for making connection with BEC (if required). Shall accommodate the requirement of the System Contractor (SYS-1) as approved by the Engineer for making earthing & bonding connections of Over Line Structures(metallic if any),	Bridges
13	Earthing & Bonding of bridges /Viaduct. – Concrete	Shall provide schematic for earthing & bonding connections with dedicated reinforcement bars in concrete of Piers cap to Piles/legs of concrete Bridges. Shall interface and get all drawings & scheme approved from the Engineer. Shall supply and Install flexible cable / jumper and connect the Terminal plates with BEC (if required) at every consecutive spans. Shall arrange adequate supervision of appropriate level and at various stages of construction to ensure the provisions of earth continuity in the concrete structures.	Shall install dedicated reinforcement earth bars in concrete to ensure earth continuity as per approved scheme. Shall allow witnessing by the contractor (SYS-1) of casting to ensure the continuity of the Earth conductor as per the scheme Shall paint marker on the designated earth bar to facilitate the supervision. Shall supply and install brought-out connections. Viz. Terminal Plates on every Pier Cap and on consecutive span of Viaduct to ensuring earthing & bonding connection with BEC (if required).	Bridges & Viaduct
14	Bridges -Cable Duct/Trough for making arrangement for cable power and control cables on Bridge.	Shall provide requirement for cable supports / ducts/ troughs along the bridge length. Shall lay cables in the Cable supports/ trough/ ducts. Shall provide manpower to apprise the Civil contractor at appropriate stage to cater for the provisions required by OHE contractors	Will provide the Cable trough, ducts, cable supports and hangers as per the designs and drawings as approved by the Engineer.	Bridges & Viaduct
15	Bridge- HDPE / GI Pipe below track for crossing the track on Bridge	Shall prepare a list showing locations where buried pipes below tracks are to be provided at the Bridge locations.	Requirement if any will be approved by Engineer. Will provide pipes of required size, as per the	Bridges & Viaduct

Item No	Item Description	System Works Contractor (SYS-1)	Civil, Building, Tunnel & Track Contractors (C-5, C-4, C-23, C-1, C-6, T-1, T-2, BR-1) - Civil Contractors and Signaling & Telecommunication Contractor (SYS-2)	Locations
		Shall remove seals at appropriate time and use the buried pipes for cable crossing and reseal at ends after use.	designs of System Contractor (SYS-1) as approved by the Engineer and close them temporarily to avoid clogging/blockage.	
16.	Stations Building and Staff Quarter for Conduiting and Fan Boxes (concealed in concrete)	Shall provide drawings for conduits and fan boxes concealed in concrete. Shall coordinate with CST contractor and confirm suitability of locations and extend all assistance to facilitate laying of conduit and fan boxes as per requirement and approved drawings. Shall furnish the drawings for the openings in Slab and beams required if any.	Shall supply and install concealed conduitsand fan boxes in concrete as per the approved drawings. Shall coordinate with the System Contractor (SYS-1) and provide the openings in the slabs and the beams as required Shall provide fish wire in conduits and ensure conduits are free from any obstructions including protecting/ sealing them temporarily.	Station Buildings and Quarters
17	Rail continuity bond/impedance bonds, cross bonds	Shall provide Rail continuity bond/impedance bonds, cross bonds as required.	Contractor (SYS-2) shall provide the SIP (Signaling Interlocking Plan) and location of provision Rail continuity bond/impedance bonds, cross bonds etc. as required	Station Areas.
18	OHE mast/structure Locations and Neutral Section (PTFE) locations	Shall provide OHE mast/structure locations and Neutral section (PTFE) locations	Contractor (SYS-2) shall provide the SIP (Signaling Interlocking Plan) and location of signals so that there is no infringement to signal, OHE and Neutral section.	Entire section
19	Scada system in OCC, TSS, SSP, SP, station building and General Electric supply sub-stations (33/11 kV/440V)	Shall provide SCADA RTU at OCC, TSS, SSP, SP, station building and General Electric supply sub-stations (33/11 kV/440V)	Contractor (SYS-2) shall provide the Telecommunication connectivity (by OFC) at RTU location and Ethernet LAN SIP at OCC, TSS, SSP, SP, station building and General Electric supply sub-stations (33/11 kV/440V).	Entire section
20	Access control System and Intruder alarm in TSS, SSP, SP.	Shall provide connection of Access control System and Intruder alarm in TSS, SSP, SP in RTU and status to be shown in OCC. Shall Coordinate with Contractor (SYS-2)	Contractor (SYS-2) shall equipment of Access control System and Intruder alarm in TSS, SSP and SP.	TSS, SSP, SP locations

18.4.2 Interface with Indian Railways

1) Items of interface With Indian Railways

Interfacing with Indian Railways will be required for:

a. Power Supply Interface at stations and line connecting to IR,

b. Data / Details Required for Simulation Studies,

c. OHE layout including provision of Neutral section and OHE interface pointbetween HORC and IR

d. Earthing of existing metallic structures of Railways in parallelism with HORC Line

2) Information Exchange

The System Contractor (SYS-1) shall share the system information and system design to establish compatibility with existing Indian Railway system

3) Interface requirements

The Interface requirements are described in **Table –18.4.2**.

Table – 18.4.2

Interfacing Requirements with Indian Railways

Item No.	Item Description	System Works Contractor (SYS-1)	Indian Railways	Remarks
1	Power Supply Interface at Junction stations with IR	The PTFE neutral sections shall be provided at inter-connecting lines between HORC and IR lines as per rules and regulations in ACTM. OHE works pertaining to yard modification of IR at connecting stations will be carried out by Contractor (SYS-1). All released material arising out of modifications shall be handed over to IR.	IR will allow access and grant necessary power blocks to integrate the HORC lines with the yard lines of IR at junction stations.	Yards of connecting stations to HORC.
2	OHE layout including provision of Neutral section and OHE meeting point between HORC and IR	The OHE layout at all junction stations covering OHE meeting point shall be coordinated with IR. This shall also require provision of jumpers at the overlaps and checking and adjusting levels at the alignment of OHE for smooth movement of LOCOMOTIVES.	IR shall approve the OHE layout for connecting Chord at crossing stations. IR shall allow access and grant power block to the contractor (SYS-1) at the time of execution, testing and commissioning. Cost of Power & Traffic Block, if any, shall be borne by HRIDC. However, if any penalty becomes leviable on account of late cancellation of Block or otherwise due to any other reasons, shall be payable by thecontractor(SYS-1).	Along the route at interface point.
3	Data / Details Required for Simulation Studies	The system Contractor (SYS-1) shall liaise with IR for seeking details of Rolling Stock/ LOCOS required for simulation for Traction and EMI/EMC studies	IR shall provide the details as required for the Simulation study.	

Item No.	Item Description	System Works Contractor (SYS-1)	Indian Railways	Remarks
4	Electromagnetic Compatibility	Shall conduct EMC Study and share the study report with IR details.	IR shall coordinate jointly with Traction Electrification, E&M and Associated Works Contractor (SYS-1) to ensure compatibility.	Electro-magnetic Compatibility
5	Earthing of existing metallic structures of Railways in parallelism with HORC Line	Shall ensure earthing of fencing and other metallic structure of Railways line (wired or unwired) adjacent and parallel with HORC's 2X25 kV OHE by mean of two separate and distinct earth connections with BEC (if required).	Shall provide list and drawings of fencing and other metallic structures running parallel to the HORC's track for long distances, Shall coordinate HORC's System Contractor(SYS-1) for suitable earthing connections.	Crossing Stations
6	Modifications in Harsana Kalan IR SSP and feeders from Harsana Kalan IR SSP to New Harsana Kalan OHE	PSI works pertaining to SSP modification at Harsana Kalan IR SSP and Feeders connecting Harsan Kalan IR SSP to New Harsana Kalan OHE will be carried out by Contractor (SYS-1). Provision of RTU and upgradation work at IR RCC for SCADA shall be done by SYS-1 Contractor. All designs and drawings shall be prepared and shall be approved by Engineer and IR.	IR shall approve the Harsana Kalan SSP modification work and feeder work and SCADA work. IR shall allow access and grant power block to the contractor (SYS-1) at the time of execution, testing and commissioning. Cost of Power & Traffic Block, if any, shall be borne by HRIDC. However, if any penalty becomes leviable on account of late cancellation of Block or otherwise due to any other reasons, shall be payable by thecontractor(SYS-1.	Harsana Kalan SSP and feeders.

18.4.3 Interface with Power Supply Authorities: for 220/132 kV Power Supply.

1) Items of interface with State Power Authority

Interfacing with the State Power Authority will be required for;

a. Power Supply Interface at Traction Substations (TSSs),

b. 220/132 kV incoming gantry to allow termination of three phase transmission line.

c. Protection Coordination with State Power Authority,

d. Shall share Design data regarding short circuit level, harmonic suppression, and ascertain that these data is used for system design.

2) Information Exchange

The System Contractor (SYS-1) shall share the information related to protection coordination and system design to establish compatibility with State Power Authority.

3) Interface requirements

The Interface requirements are described in **Table –18.4.3**.

Table – 18.4.3

Interfacing Requirements with : State Power Authority

Item No.	**Item Description**	**System Works Contractor (SYS-1)**	**State PowerAuthority**	**Remarks**
1	220/132 kV Incoming Bay	Shall provide 220/132 kV incoming gantry to allow State Power Authority to terminate double circuit three phase transmission line inside the TSS.	Shall coordinate with HRIDC and withthe System Contractor (SYS-1).	TSS
2	Design Data of Traction Installation	Shall propose a protection scheme and obtain approval from Power Supply Utilities: State Power Authority. Shall ascertain the adequacy of the provisions as per the requirements of State Power Authority and share Various design information viz. ▪ TSS Protection Scheme & Relay coordination ▪ Harmonic suppression, ▪ short circuit level	Shall verify and approve the final scheme of protection. Shall coordinate with HRIDC's System Contractor (SYS-1) and share the relevant information.	TSS/GSS
3	Metering Equipment	Shall provide necessary check meters for measurement of voltage, current, p.f., kVA, kVARh, kWh, at TSSs. Shall co-ordinate with StatePower Authority for proper readings. Transmit the Energy and power quality data to OCC.	Shall provide necessary tariff meters for measurement of voltage, current, p.f., kVA, kVARh, kWh, at TSS as required.	TSS

Item No.	Item Description	System Works Contractor (SYS-1)	State PowerAuthority	Remarks
4	Earthing	Shall propose an earthing arrangement at the TSSs in consultation with StatePower Authority. Shall make necessary arrangement for earthing.	Shall scrutinize and approve earthing arrangement.	TSS
5	Interface	Issues on interaction during design, construction and execution should be resolved to the satisfaction of State Power Authority. These issues may relate to metering, and on timing of completion, testing and commissioning.	Shall coordinate with HRIDC and with the System Contractor (SYS-1).	TSS
6	Design consideration due to feed from State Power Authority transmission line network.	The Contractor Design Simulation as required should be undertaken in consideration of the source of power supply from State Power Authority.	State PowerAuthority will share the information regarding the sources of power supply including parameters of transmission line and feeding Grid Substations as required for design in case may be.	TSS
7	Control and Monitoring equipment at TSS	Shall provide space to install control panel cubicle and shall provide LV power supply to the State Power Authority at the TSS	Shall install control panel cubicle in the control room of HRIDC TSS	TSS

18.4.4 Interface with Indian Railway, DFCCIL and Contractor MSIL(OHE) for OHE at the boundary location

1) Interfacing with the Indian Railways, DFCCIL and Contractor MSIL(OHE) will be required for;

a. Design of OHE, SCADA and Earthing & Bonding arrangements at boundary locations at:

1) Sultanpur, Asaudah and New Harsana Kalan with Indian Railways.

2) Pirthla with DFCCIL

3) Patli with Contractor MSIL(OHE)

b. Erection of OHE structure, Earthing & Bonding arrangements at boundary locations at Sultanpur, Asaudah, Harsana Kalan, Pirthla and Patli.

2) Information Exchange

The System Contractor (SYS-1) shall share the information of system design and establish compatibility in OHE and Earthing & Bonding arrangements at boundary location,

3) Interface requirements

The Interface requirements are described in **Table –18.4.4**.

Table – 18.4.4

Indicative Interface with Indian Railways, DFCCIL and Contractor MSIL(OHE) at boundary locations;-

Item No	**Item Description**	**System Contractor (SYS-1)**	**Indian Railways, DFCCIL and Contractor MSIL(OHE)**
1.	Design and erection of OHE and Earthing & Bonding and SCADA arrangements at boundary locations at Sultanpur, Asaudah and New Harsana Kalan.	• Shall coordinate and share the design for the common section to finalize the plan. Shall coordinate with MSIL(OHE) contractor for providing overlap for New Patli - Patli meeting point. Shall coordinate with Indian Railways for finalising the locations of portals and/or single line cantilever structures. • If portals are required to be provided for the common section, Contractor (SYS-1) shall provide and install mast / structure as per design and asapproved by the engineer. • Shall coordinate and provide SCADA controls at IR SCADA centre. • The charges claimed by Indian Railways and DFCCIL for granting traffic/power block etc. for yard modification work and OHE connections shall be borne by the Employer (HRIDC).	• Shall design and prepare OHE Layout Plan in coordination with Contractor (SYS-1) including PTFE, OHE overlaps upto the boundary location and shall get consent of the Engineer. • Shall coordinate with Contractor (SYS-1) and decide the locations of portals and/or single line cantilever structures, as the case may be for the common run. • Shall provide the Power Blocks to Contractor (SYS-1) for making changes in OHE as per approved drawings. • Shall coordinate with Contractor (SYS-1) for SCADA controls and indications which are required by IR in their OCC.
2.	SCADA arrangements at boundary locations at Patli station (IR).	• Shall coordinate with Contractor MSIL(OHE) and install all equipments at OCC Manesar to control and monitor status of Patli SP.	• Contractor MSIL(OHE) shall coordinate with Contractor (SYS-1) and provide all SCADA system of Patli SP to Contractor (SYS-1) who shall provide all controls and indications of Patli SP at OCC, Manesar.
3.	SCADA arrangements at boundary locations at Prithla SP	• Shall coordinate with DFCCIL and provide SCADA controls and indications of Prithla SP as per DFCCIL requirements (OCC of DFCCIL).	• Shall coordinate with Contractor (SYS-1) and give their SCADA system requirements of Prithla SP which are essential for DFCCIL for control and indications purpose.

(End of Chapter 18)

CHAPTER 19 –APPENDICES ON ABBREVIATIONS, SPECIFICATIONS

INDEX

Appendix No.	Description
1.	Definitions
2.	Abbreviations
3.	List of Indian Standards
4.	List of International Standards (EN/BS/IEC/IEEE/ISO/UL etc.)
5.	RDSO specifications
6.	RDSO Drawings
7.	CORE's Drawings
8.	Specifications of 60/84/100 MVA Scott connected Traction Transformer
9.	Specifications of 8-MVA Auto-Transformer (based on which the Specification for higher Capacity MVA Auto Transformer shall be drawn by the Contractor covering all aspects.)
10.	Joint Deed of Undertaking by the Qualified Equipment Manufacturer along with theContractor and Indian Equipment Manufacturer/Indian Partner
11	Access Control System

Appendix-1

Definitions

Terminology	Explanation/definition
Acceptance Measurement	Final definitive records of the measurement of the installed contact wire heights and staggers at OCS support and at mid-spans.
Accessible voltage (Vacc)	The part of the rail potential under operating conditions that can be bridgedby persons, the conductive path being conventionally from either hand to both feet through the body, or from hand to hand.
Aerial Earth Wire	A conductor on traction masts/structures/ supports and bonded to their metallic parts/ supports and connected to earth.
Auto Transformer	A transformer with a single winding that is Centre tapped to provide a zero potential traction return connection. The +25kV terminal is connected to the catenary and the -25kV terminal is connected to the autotransformer feeder or negative feeder.
Auto Transformer Station	A building or compound containing electrical switchgear, equipment and autotransformer(s) which are arranged to connect together a number ofsections of overhead line equipment.
Auto-Tensioned Equipment	OCS conductors terminated with Auto Tensioning device with balance weights, springs or hydraulic tensioning devices to maintain constant tension.
Bonding	The electrical connection of two or more conductive parts to ensure a continuous path for electric current, or to maintain the connected parts atsubstantially the same potential.
British Standard	A standard published by the British Standards Institution. Its alphanumeric identity is prefixed by BS.
Common Bonding Network (CBN)	The CBN is the principle means for effecting bonding and earthing inside a building. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network in a building. These components include: structural steel or reinforcing rods, metallic plumbing, AC power conduit, cable racks and bonding conductors.
Cross-Bond	In addition to longitudinal-bond on each track, the two tracks are bonded together via Traction Spider Plates.
Earth Electrode	A conductive part or a group of conductive parts in intimate contact with and providing an electrical connection to earth.
Earth Mat	A group of conductor rods connected together as a grid, with or without earthing electrodes normally connected at the grid points.

Terminology	**Explanation/definition**
Earth Wire	A conductor electrically connecting together the steelwork of two or more overhead line structures or a number of overhead line small-part steelwork assemblies and bonded to a traction return rail or to the Centre tap of an impedance bond.
Earth	The conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero.
Electrical Section	A length of overhead line equipment between switching stations or between a switching station and a terminal end.
Electrification System	Electric power distribution system along track which can be on side rails or overhead and distributes power from Feeder Stations to the train's currentcollection system.
Equipotential Bonding	Electric connections ensuring that exposed conductive parts and all extraneous conductive parts are maintained at substantially equal potential.
European Standard	A standard published by the European Committee for Standardization or bythe European Committee for Electro-technical Standardization. Its alphanumeric identity is prefixed by 'EN'.
Fault Current	The current that flows as a result of an unintentional electrical fault on the electrification system, such as a short circuit or flashover.
Feeding Section	A feeding section is defined as the section of overhead line between successive TSS/SP on either side of a feeder station.
First Emergency Feeding	The feeding arrangement when one of two feeder circuits to the feeder station has failed (in the case where the feeder station is fed by two feeder circuits). For feeder stations with one feeder circuit, the feeder circuit shall be used to T-feed the sections in both directions. In the latter case, normal and first emergency feeding arrangements are the same.
International Standard	A standard published by the International Electro-technical Commission. Its alphanumeric identity is prefixed by 'IEC'.
Load Current	The current that flows as a result of the operation of electric trains.
Metallic Service	A service having an exposed metallic surface, such as a gas or water pipe, a conduit, or a metal-sheathed cable.
Normal Feeding	The feeding arrangement when both 132 kV feeder circuits to the Traction Sub-station are healthy and available for service. All feeder circuits shall be used to radial feed their respective sections with a neutral section between them.

Terminology	Explanation/definition
Overhead Contact line Zone	The zone whose limits are not exceeded, in general, by a live, broken overhead line conductor. The term applies to out-of-running overhead line conductors but not to those conductors that are not mechanically strained by pantographs, because the probability of breakage is too small. The profileand dimensions of the zone are defined in BS EN 50122-1. See also pantograph zone.
Pantograph Zone	The zone whose limits are not exceeded, in general, by a live, broken or de-wired pantograph. Its profile and dimensions are defined in BS EN 50122-1. See also overhead contact line zone.
Rail Potential	The voltage occurring between the traction return rails and earth under operating conditions and or under fault conditions.
Return Conductor	A conductor connected in series with the secondary windings of booster transformers, and bonded to the traction return rails to carry traction return current back to a feeder station independently of the running rails. However here it will be referred interchangeably as Negative feeder or Return conductor or Return feeder.
Second Emergency feeding	The feeding arrangement when both the feeder circuits to the feeder station have failed (in the case where the Feeding Station is fed by two feeders circuits), or when the single feeder to the feeding station has failed (in the case where the Feeding Station is fed by a single feeder circuit). The affected sections are fed by the adjacent feeder stations.
Simultaneous Touching Distance	The distance which can be bridged by a person. In general a minimum horizontal dimension of 2m and a minimum vertical dimension of 2.5m areadopted.
Stray Current	Electric current that follows paths other than intended paths. Stray currents occur in A.C. traction systems but only d.c. stray current is corrosive to steel structures.

Terminology	Explanation/definition
Touch Potential, Touch Voltage (Vtouch)	The electrical potential difference between two parts at different electrical potentials under fault conditions that is experienced when touched.
Traction Power Supply System	The Traction Power supply System is defined as the Infrastructure between the point of common coupling with Power Supply Utilities and the pantograph of the Locomotive and Rail.
Project Wide	Project Wide is defined as HORC Project Prithla – New Harsana Kalan section and includes all contractors working on the section like CST (Civil and Track work – contractor)
Proven	The proposed system / equipment to be used should be of proven performance and record of at least two years. The same should have been in use in adequate numbers (at least two unless specifically asked more) in Metro / Railway system or Power Utilities.

Appendix-2

Abbreviations

AC	Alternating Current
ACO	Automatic change over switch
ACS	Access Control (Rail System)
ACTM	Alternating Current Traction Manual
AMS	Asset Management System
AT	Auto Transformer
ATS	Auto Transformer Stations
ATD	Auto Tensioning Device
Aux	Auxiliary
BIS	Bureau of Indian Standards
BWA	Balance Weight Assembly
CB	Circuit Breaker
CEA	Central Electricity Authority – Government of India
CORE	Central Organization for Railway Electrification
CBT	Computer Based Training
DFC	Dedicated Freight Corridor
DFCCIL	Dedicated Freight Corridor Corporation India Limited
DSC	Double Stack Container
DLP	Defect Liability Period
EPDM	Ethylene Propylene Diene Monomer
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FMECA	Failure modes, effects and criticality analysis
FOB	Foot Over Bridge
GS	General Specifications
GSS	Grid Substation
HF	Human Factors
HFIP	Human Factors Integration Plan
HV	High Voltage
I/O	Input/ output
IR	Indian Railway
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers Inc.
IPR	Intellectual Property Rights
IS	Indian Standards

LV	Low Voltage
MMD	Maximum Moving Dimension
MPCC	Main Power Control Centre
MOU	Memorandum of Understanding
OCS	Overhead Contact System
OFC	Optical Fibre Cable
OHE	Overhead Equipment
ONAN	Oil Natural Air Natural
ONAF	Oil Natural Air Forced
PCB	Poly Chlorinated Biphenyls
PDF	Portable Document Format
PHA	Polycyclic Aromatic Hydrocarbons
PLC	Programmable Logic Controllers
PS	Particular Specifications
RAM	Reliability, availability and maintainability
RAMS	Reliability, availability, maintainability and safety
RBD	Reliability Block Diagram
RDSO	Research Design and Standard Organization under the Ministry of Railways
RTU	Remote Terminal Unit
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SQE	Safety, Quality and Environment
SSP	Sub-Sectioning Post
SP	Sectioning Post
SCP	Supply Control Post
SPS	Small Part Steelwork
SSOD	Standard Schedule of Dimensions
SAT	Site Acceptance Test
TBA	To be advised
TSS	Traction Substation
TOT	Transfer of Technology
XLPE	Cross Linked Polyethylene

Appendix-3

List of Indian Standards (IS)

Sr.	Number of IS	Description
1.	226-1975 814-1974 816-1969 823-1964 6227-1971	Structural steel (standard quality) Specification for mild steel and tinplate drums Code of practice for use of metal arc welding for general construction in mild steel Code Of Procedure For Manual Metal Arc Welding Of Mild Steel Code Of Practice For Use Of Metal Arc Welding In Tubular Structure
2.	269-1989 (4th rev.)	Specifications for 33 grade ordinary Portland cement.
3.	335-1993	New Insulating Oils.
4.	383-1970 & 515-1959	Fine & coarse aggregates for concrete.
5.	432-1982	Specifications for mild steel and medium tensile steel bars and hard drawn steel wires for concrete reinforcement.
6.	694-1990	PVC Insulated cables for working voltages up to and including 1100 Volts.
7.	1248-2003	Direct Acting Electrical Indicating Instruments.
8.	1554-1988	PVC Insulated (Heavy Duty) Electric Cables
9.	1753-1967	Aluminium conductors for insulated cables.
10.	2099-1986	Bushing for Alternating Voltages Above 1000V (2nd Revision).
11.	2705-1992	Current Transformers.
12.	2834-1986	Shunt Capacitors for Power Systems
13.	3043-1987	Code of Practice for Earthing.
14.	3156-1992/4146-1983	Voltage Transformers/Application Guide for Voltage Transformers.
15.	3231	Electrical Relays for Power System Protection.
16.	3401-1992	Specifications for Silica Gel.
17.	3427-1997	Metal Enclosed Switchgear & Control Gear for Voltages Above 1000V up to and Including 52000V.
18.	3639-1966	Fittings and accessories for power transformers.
19.	3842	Application guide for electrical relays for ac systems
20.	3961-1968 (Part III)	Recommended current ratings for cables.
21.	5138-1978	Enclosure construction with single Sheet sturdy frame construction.
22.	5216	Recommendations on Safety Procedures and Practices in Electrical Work.
23.	5891-1970	Recommended Short Circuit Rating of High Voltage XLPE Insulated PVC Cables.
24.	6600-1972 /	Guide for Loading of Oil Immersed Transformers.
25.	10561-1983/	Application Guide for Power Transformers.
26.	10593-2006	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis.

Appendix-4

List of International Standards (DIN/EN/BS/IEC/IEEE/ISO/UL etc.)

S. No	Standard Number	Description
1.	BS 5308	Instrumentation cables – Part 1 Specifications for polyethylene Cables
2.	BS 7671	Requirements for Electrical Installations.
3.	BS 7835	Specifications for cables with cross-linked polyethylene or ethylene propylene rubber Insulation for rated voltages from 3800/6600 V up to 19000/33000 V having low emission of smoke and corrosive gases when affected by fire.
4.	BS EN 50082-1	Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry.
5.	DD ENV 50121 (All parts)	Railway applications - Electromagnetic compatibility.
6.	DIN 43668	Key for the doors of electrical switchgear cubicles and cabinets; double-bit key.
7.	DIN 43671	Copper bus bars; design for continuous current.
8.	DIN 43761	Temperature Sensors.
9.	DIN 53504	Tensile strength.
10.	DIN 53577	Compressive strength.
11.	DIN EN 13601	Copper rod, bar and wire for general electrical purposes.
12.	EN ISO 9001	Quality systems: Model for quality assurance in design, development, production, installation and servicing.
13.	EN 50119	Railway Applications - Fixed installations- Electric traction overhead lines.
14.	EN 50121	Railway applications - Electromagnetic compatibility.
15.	EN 50122	Railway Application - Fixed Installations, Electrical Safety, Earthing and return circuit.
16.	EN 50124-1	Insulation Co-ordination in Traction Systems.
17.	EN 50125-2	Environmental Conditions for Fixed Installations.
18.	EN 50126	Railway applications: The specifications and demonstration of dependability, reliability, availability, maintainability and safety (RAMS).
19.	EN 50149	Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires.
20.	EN 50152	Railway Applications- Fixed Installations - Particular requirements for AC Switchgear. (All parts).
21.	EN 50522	Earthing of Power System exceeding 1 kV/ac
22.	EN 50163	Railway Application - Supply Voltages of traction systems.
23.	EN 50272 (Part 2)	Safety requirements for secondary batteries and battery installations - Stationary batteries
24.	EN 50329	Railway applications. Fixed installations. Traction transformers.
25.	EN 60051	Direct acting indicating analogue electrical measuring instruments and their accessories.
26.	EN 60076	Power Transformers / Reactors
27.	EN 60137	Insulated Bushings for Alternating Voltages above 1kV.
28.	EN 60417	Graphical symbols for use on equipment.

S. No	Standard Number	Description
29.	EN 60507	Artificial pollution tests on high-voltage insulators to be used on ac systems.
30.	EN 60529	Specifications for the degree of protection provided by enclosures (IP code).
31.	EN 60721	Classification of environmental conditions. Environmental parameters and their severities.
32.	EN 60896-2	Stationary lead-acid batteries. General requirements and methods of test. Valve regulated types.
33.	EN 61140	Protection against shock – Common aspects for installation and equipment.
34.	EN 61230	Live Working – Portable Equipment for Earthing or Earthing and short circuiting.
35.	EN 61325	Insulators for Overhead Lines with Nominal Voltages above 1000 V.
36.	EN 61508	Functional safety of electrical/ electronic/ programmable electronic safety related systems.
37.	EN 61952	Insulators for overhead lines. Composite line post insulators for alternating current with a nominal voltage.
38.	EN 62271	High-voltage switchgear and control gear.
39.	IEC Hand Book for Temperature Index	Cable in fire regarding temperature Index Chapter-6.
40.	IEC 60068	Environmental Testing
41.	IEC 60296	Bushings for alternating voltages above 1000 Volts.
42.	IEC 61508	Functional Safety – Programmable Safety related systems.
43.	IEC 60044	Instrument transformers – current transformers.
44.	IEC 60076	Power Transformers.
45.	IEC 60255	Measuring Relays and Protection Equipment.
46.	IEC 60376	Specifications of technical grade Sulphur Hexafluoride (SF6) for use in electrical equipment.
47.	IEC 60502	Power Cables - Extruded Insulation for rated voltages from 1 kV up to 30 kV.
48.	IEC 60616	Terminal and tapping markings for power transformers.
49.	IEC 60850	Railway applications – Supply voltages of traction systems.
50.	IEC 61000	Electromagnetic compatibility.
51.	IEC 61243	Line working - Voltage Detector.
52.	IEC 62128	Railway applications - Fixed installations - Part 1: Electrical safety, earthing and return circuit.
53.	IEC 62236	Railway Applications – Electromagnetic Compatibility.
54.	IEC 62271	High Voltage Switchgear and Control Gear above 53 kV.
55.	IEC 62695	Traction Transformers.
56.	IEEE80:2013	Guide for safety in ac substation grounding.
57.	IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Grid System.
58.	IEEE 485	IEEE Recommended Practice for Sizing of Large Lead Storage Batteries for generating Station and Substations.
59.	IEEE 738	Standard for Calculating Current-Temperature of Bare Overhead Conductors.
60.	IEEE 980	Guide for Containment and Control of Oil Spills in Substations.

S. No	Standard Number	Description
61.	IEEE 1187	Recommended Practice for Installation Design and Installation of Valve-regulated Lead acid Storage batteries for Stationary Applications.
62.	IEEE 1188	IEEE Recommended Practice for Maintenance, Testing and Replacement of valve-regulated Lead Acid (VRLA) Batteries for Stationary Applications.
63.	IEEE 1189	IEEE Guide for Selection of Valve-regulated Lead Acid (VRLA) Batteries for Stationary Applications.
64.	IEEE 1313.1	Standard for Insulation Coordination
65.	IEEE C2	National Electrical Safety Code.
66.	IEEE C37.30	Standard requirements for High-Voltage Switches.
67.	IEEE C37.32	HV switches, Bus Supports and Accessories, Schedule of Preferred Ratings, Construction Guidelines and Specifications.
68.	IEEE C37.37	Standard Loading Guide for AC HV Air switches (in excess of 1000V).
69.	IEEE C57.93	Guide for Installation of Liquid Immersed Power transformers.
70.	IEEE C95.1	Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
71.	IEEE C95.6	Standard for Safety Level with respect to Human Exposure to Electromagnetic Fields 0-3 kHz.
72.	IEEE 525	Guide for installation of cable systems in substations
73.	IEEE 979	Guide for substation Fire protection
74.	IEEE 998	Guide for direct Lightning stroke shielding of substations
75.	ISO 3864	Graphical symbols -- Safety colours and safety signs.
76.	ISO 17398	Safety colours and safety signs.
77.	NEC 300-21	Spread of Fire or Products of Combustion.
78.	NEMA 250	Enclosures for Electrical Equipment.
79.	NEMA AB1	Moulded Case Circuit Breakers and Moulded Case Switches.
80.	NEMA BU1	Bus ways.
81.	NEMA SG5	Power Switchgear Assemblies.
82.	NEMA SG6	Power Switching Equipment.
83.	NEMA TR208	Disconnect Switchgear Insulators.
84.	NFPA 70	National Electrical Code.

Appendix-5

List of RDSO Specifications

S. No	Specifications No.	Description
1	ETI/OHE/3	Technical specifications for Annealed stranded copper conductors for jumper wire for Electric Traction.
2	ETI/OHE/11	Specifications for steel tubes.
3	ETI/OHE/13	Specifications for Hot dip zinc galvanization of steel masts (Rolled & Fabricated), tubes and fittings used on 25kV ac OHE.
4	ETI/OHE/16	Specifications for 25kV ac single pole and double pole isolators for Railway Electrification.
5	ETI/OHE/18	Specifications for Steel and stainless steel bolts, nuts and washers.
6	ETI/OHE/21	Aluminum alloy section and tubes for 25kV Traction Overhead Equipment.
7	ETI/OHE/27	Section Insulator assembly without sectioning insulator.
8	ETI/OHE/33	Specifications for Enameled steel plates.
9	ETI/OHE/33A	Provisional specifications for "retro-reflective structure Number plates."
10	ETI/OHE/36	Specifications for Galvanized steel wire rope.
11	ETI/OHE/42	Technical specifications for hard drawn grooved contact wire for electric traction (jointed/welded contact wire).
12	ETI/OHE/48	Technical specifications for Winch type regulating equipment for 25kV ac traction.
13	ETI/OHE/49	Technical specifications for Fittings for 25 kV ac OHE.
14	ETI/OHE/50	Technical Specifications for cadmium copper conductors for overhead Railway traction.
15	ETI/OHE/51	Specifications for Discharge/earthing pole assembly for 25kV ac traction.
16	ETI/OHE/52	Specifications for Interlocks for ac traction switchgears.
17	ETI/OHE/53	Principles for OHE layout plans and sectioning diagrams for 25kV ac traction.
18	ETI/OHE/54	Specifications for 19/2.79mm all aluminum alloy stranded catenary wire.
19	ETI/OHE/55	Specifications for Bimetallic (aluminum-copper) strip.
20	ETI/OHE/58/1	Specifications for hand operated lifting and swiveling platform.
21	ETI/OHE/64	Specifications for solid core cylindrical post insulators for systems with nominal voltages of 220kV, 132kV, 110kV & 66kV.
22	ETI/OHE/65	Specifications for continuous cast copper wire rods.
23	ETI/OHE/71	Code of bonding and earthing for 25kV ac 50Hz single phase tractionsystem.
24	ETI/OHE/76	Technical Specifications for hard drawn grooved contact wire for

S. No	Specifications No.	Description
		electric traction drawn out of continuous cast copper (ccc) wire rods.
25	ETI/PSI/1	Battery charger for 110 volt battery, 40 Ah.
26	ETI/PSI/14	Technical specifications for 25kV drop out fuse switch and operating pole for use with 110kVA and 100kVA, 25k/240V LT supply transformers.
27	ETI/PSI/15	Specifications for 25kV/240V, 5 kVA, 10kVA, 25kVA & 50kVA, 50 Hz, single phase, oil filled auxiliary transformers for Railway AC traction system.
28	ETI/PSI/15A	25kV/240V L.T. supply Transformer, 100kVA.
29	ETI/PSI/24	Battery charger for 110V Battery, 200 AH.
30	ETI/PSI/29	Low tension Distribution panels for Railway A.C traction sub-stations.
31	ETI/PSI/31	Standard for Drawings for power supply Installations.
32	ETI/PSI/63	Low tension distribution panels.
33	ETI/PSI/71	Metal oxide gapless type lightning arrester for use on 25 kV side ofRailway traction substations and switching stations.
34	ETI/PSI/90	25 kV ac 50 Hz single phase oil filled current transformers with ratio of (i) 1000-500/5A, (for general purposes), (ii) 1500-750/5 (for heavy duty).
35	ETI/PSI/117	Technical specifications for current transformers: I. 220kV. 200-100/5A, II. 132kV. 400-200/5A, III. 110kV.400-200/5A, IV. 66kV.800-400/5A for Railway A.C traction substations.
36	ETI/PSI/120	Code of practice for earthing of power supply installations for 25kV ac, 50 Hz, single phase traction system.
37	ETI/PSI/122	Technical Specifications for 245 kV, 145 kV, 123 kV, 72.5 kV, Double Pole & Triple Pole Isolator for Railway Traction Sub-Stations.
38	ETI/PSI/123	8MVA, 54kV 50Hz, Auto Transformer for Railway 2 x 25kV AT Feeding System.
39	ETI/PSI/124	54 MVA, 220/2 x 27kV Scott connected Traction Power Transformer for 27 kV AT feeder system for Railway ac Traction Sub-station.
40	ETI/PSI/132	25 kV double pole outdoor, vacuum interrupters for Railway switching stations for 2x25 kV 'AT' feeding system.
41	ETI/PSI/133	25kV ac Double Pole Isolators for 2 x 25kV AT feeding system.
42	ETI/PSI/137	Metal oxide gapless type lightning arresters for use of 220/132/110/66 kV side of railway ac traction substation.
43	ETI/PSI/167	25kV AC 50Hz single pole, outdoor interrupter for Railway traction switching stations.
44	RE/30/OHE/5	Specifications for Copper bus bar.
45	RE/OHE/25	Standard for Drawings for Traction Overhead equipment.

S. No	Specifications No.	Description
46	RDSO/PE/SPEC/AC/ 0100,(Rev.'1') - 2011	Technical Specifications for Double capped tubular T5 Fluorescent lamps, T5 luminaire & Electronic ballast.
47	RDSO/PE/SPEC/TL/ 0040-2003 (Rev-0)	Specifications for low maintenance lead acid batteries for 40 Amp hour and 200 Amp hour cells for traction distribution system.
48	TI/SPC/LWTSI/0060	Specifications for light weight section insulator assembly.
49	TI/SPC/OHE/ATD/ 0060	Specifications for Three pulley type regulating equipment (3:1 Ratio).
50	TI/SPC/OHE/FRPNP/ INS/COM/ 1070	Technical specifications for silicon composite insulators for 25kV ac 50Hz single phase overhead traction lines.
51	TI/SPC/OHE/GALST B/0040	Technical specifications for galvanized steel stranded wire for traction bonds for 25kV ac Electric traction systems.
52	TI/SPC/OHE/GATD/ 0080	Technical specifications for gas auto tensioning device.
53	TI/SPC/OHE/GSSW/ 0090	Schedule of technical requirements for manufacture of Galvanized steel stranded wire (GSSW).
54	TI/SPC/OHE/HDCSC F/0030	Technical specifications for 37/2.25mm Hard Drawn Stranded copper conductor.
55	TI/SPC/OHE/INS/007 0	Specifications of solid core porcelain insulators for 25kV A.C 50 Hz single phase overhead traction lines.
56	TI/SPC/OHE/INS/070 0	Specifications for stainless steel wire rope.
57	TI/SPC/OHE/INSCAT /0000	Insulated Cadmium Copper Catenary 19/2.1mm. Diameter for provision under overhead line structures in the 25kV ac Electric Traction.
58	TI/SPC/OHE/INSTES T/0090	Specifications for Testing load testing machine 25kV Porcelain & Composite insulator before installation.
59	TI/SPC/OHE/POST/ 0100	Specifications for solid core porcelain cylindrical post insulator for systems with nominal voltage of 66kV, 110kV, 132kV & 220kV.
60	TI/SPC/OHE/SNS/ 0000	Specifications for short Neutral section assembly (Phase Break).
61	TI/SPC/OHE/WR/106 0	Specifications for solid porcelain insulators for 25kV ac 50hz single phase overhead traction lines.
62	TI/SPC/PSI/CB/0000	Outdoor Circuit Breaker for Railway ac Traction Sub-stations.
63	TI/SPC/PSI/FC&SR/ 0100	Technical specifications for shunt capacitor & series reactor equipment for traction sub-station.
64	TI/SPC/PSI/ISOLTR/ 1060	25kVac Single Pole and Double Pole Motorized Isolators for Railway Traction.
65	TI/SPC/PSI/MOGTLA /0100	42 KV Metal oxide gapless type lightning arrester for use on 25 KVside & Railway Traction substation and Switching Station.
66	TI/SPC/PSI/PROTCT /1982	Specifications for Delta-I type High Resistive fault selective relay for 25 kV ac traction systems.

S. No	Specifications No.	Description
67	TI/SPC/PSI/PROTCT /2983	Specifications for Panto Flashover Protection relay for 25 kV ac traction System.
68	TI/SPC/PSI/PROTCT /6070	Control and relay panel for 25kV ac TSS including specifications for numerical type protection relays for traction transformer, 25kV shunt capacitor bank and transmission line for 25kV AC TSS on Indian Railways.
69	TI/SPC/PSI/PROTEC T/7100	Technical specifications for control and relay panel including numerical type protection relays for Scott-connected/single phase traction transformers, OHE protection and shunt capacitor bank protection for 2x25 kV traction sub-station.
70	TI/SPC/PSI/PTs/099 0	Technical specifications for 220kV or 132kV or 110kV or 66kV or 25kV potential transformer.
71	TI/SPC/PSI/VACINT/ 0040	Magnetic actuator type 25 kV ac, 50 Hz, single pole, outdoor vacuuminterrupter for railway traction switching Station.
72	TI/SPC/RCC/SCADA / 0130 (Rev-2)	Specifications for SCADA
73	TI/SPC/PSI/TRNPWR/ 5200	Technical specifications for 60/84/100 MVA ONAN/ONAF/OFAF 220/132kV/2x55 kV Scott- connected Traction Power transformer.
74	TI/SPC/PSI/AUTOTR/ 1200	Technical specifications for 8& 16.5MVA ONAN 55kV/27.5kV Autotransformer
75	TI/SPC/PSI/40-150/ CHGR/1210	Battery charger for 110 V battery, 150AH for (2x25 kV) and 40 AH (for 25 kV) at SP/SSP for Electric Traction Installation
76	TI/SPC/PSI/200- 250/CHGR/0210	Technical specification for Battery charger for 110 V battery, 200/250AH, at Traction Sub-station for 25kV/2x25 kV Electric Traction Installation
77	TI/SPC/PSI/CT/0210 (07/2021) 40-150/ CHGR/1210	Technical specification for Current Transformers with ratio of 220 kV, 400-200.5A and various others for Railway AC TRACTION SUBSTATIONS
78	TI/SPC/OHE/Fittings/ 0130/(10/13) Rev.1	Technical specification for 25 kV AC OHE Fittings
79	TI/SPC/PSI/ EARTHING/0210	Technical specification for Earthing of Power Supply Installations for 25 kV and 2x25 kV AC, 50 Hz Traction System.
80	TI/SPC/PSI/ISOLTR/ 0210 (Addendum & corrigendum No.1)	Technical specification for 25 kV Motorised/Manual operated and 50kV/66kV/100kV/110kV/132kV/220kV Manual operated Single Pole, Double Pole and Triple Pole Isolators for Railway Electric Traction.
81	TI/SPC/PSI/HVCB/ 0121 (Addendum & corrigendum Slip No.1)	Specification for 220kV/132kV/110kV/100kV/66kV/55kV Double Pole, Triple Pole Outdoor SF6 Circuit Breaker for Indian Railway
82	RDSO/PE/SPEC/TL/ 0040 (Rev.2) - 2021	Specification for Low Maintenance Lead Acid 40AH, 150AH, 200AH and 250AH Cells for Traction Distribution System.
83	TI/SPC/OHE/ INSCOM/1072	Technical Specification for Silicone Composite Insulators for 25 kV, AC, 50 Hz, Single Phase Overhead Traction Equipment.
84	ETI/OHE/71 (11/90) – Rev.1	Code for Bonding and Earthing for 25 kV, AC, 50 Hz, Single Phase Traction System.

85	TI/SPC/PSI/PROTCT/ 7101	Technical specification for Control and Relay Panel Including Numerical type protection relays for Scott-connected/V-Connected Single-Phase Traction Transformers, OHE Protection, 55 kV AT Protection & Shunt Capacitor Protection for 2x25 kV Traction Sub-station, Sectioning and Paralleling Post, Sub-Sectioning & Paralleling Post, and Auto Transformer Post.
86	TI/SPC/OHE/POST/ 0101 (June, 2022)	Specification for Solid Core Porcelain Cylindrical Post Insulators for Systems with Nominal Voltage of 66kV, 110kV, 132kV & 220kV.
87	TI/IN/0038 (Feb, 2019)	Technical Instruction for Earthing practices on various types of Bridges.
88	TI/SPC/OHE/CAT (Cu-Cd)/0971	Technical Specification for Cadmium Copper Conductors for Over Head Electric Traction
89	TI/SPC/OHE/CW /0971	Technical Specification for Hard Drawn Grooved Copper Contact Wire for Electric Traction
90	TI/SPC/OHE/GALSTB /0040 Rev.1 (April, 2022)	Technical Specification for Galvanised Steel Stranded Wire for Traction Bonds for 25 kV AC, Electric Traction System
91	TI/SPC/OHE/INS/0071 (April, 2022)	Technical Specification for Solid Core Porcelain Insulators for 25 kV, AC, 50 Hz, Single Phase Overhead Traction Lines.
92	TI/SPC/OHE/STRIP (Al-Cu)0901 (January, 2021)	Technical Specification for Bimetallic (Aluminium-Copper) Strip.
93	TI/IN0041 (September, 2020)	Guidelines for Rigid Catenary Overhead Conductor System for use in Tunnels
94	TI/SPC/OHE/ HDCSCF/0031	Technical specification for Hard Drawn Stranded Copper Conductor
95	TI/SPC/PSI/ISOLTR /0210 (July, 2021)	Technical specification for 25 kV motorized/manual and 55/132/220 kV manual operated single pole, double pole, triple pole isolators.
96	TI/SPC/PSI/CLS/0020 (amendment-4 or latest)	Technical specification for Control & Distribution panel for Colour Light Signalling supply and emergency loads in 25 KV AC traction System.

Appendix-6

List of RDSO Drawings

Sl. No	Brief Description	Drawing		Mod. No.
		Series	Number	
1	Typical location & schematic connection diagram for a three interrupter switching station.	ETI/PSI	003	C
2	Typical general arrangement of a three interrupter switching station.	ETI/PSI	004	F
3	Typical location plan & general arrangement for sectioning & paralleling station.	ETI/PSI	005	F
4	Typical location plan and general arrangement for a feeding station.	ETI/PSI	006	E
5	Details of foundation for fencing upright.	ETI/C	0032	B
6	Details for pre-cast cable trench for switching station.	ETI/C	0038	E
7	Remote Control Cubical at station, Foundation, RCC Slab, building plant and steel door.	ETI/C	0067	B
8	Protective screen of foot-over bridge and road over-bridge.	ETI/C	0068	G
9	Typical fencing and anti-climbing arrangement at switching stations.	ETI/PSI	104	E
10	Typical fencing layout at TSS (Details of Fencing panel, door, anti-climbing device etc.).	ETI/PS2	121	F
11	General arrangement & details of fencing panels & gate for switching stations.	ETI/C	0186 Sh.I& II	E
12	Typical earthing layout of sub- sectioning and paralleling station.	ETI/PSI	201	B
13	Typical Cable trench layout and foundation layout of 132/ 25kV TSS.	ETI/C	0210	F
14	Details of baffle wall at TSS (WP-112.5 Kg f/m2 andWP-75 kg f/m^2).	E TI/C	0213	D
15	Details of RCC baffle wall at TSS (WP-150kgf/m^2).	ETI/C	0214	B
16	Transformer oil drainage arrangement at substations.	ETI/C	0216	B
17	Arrangement for false catenary under over line structure.	ETI/OHE/SK	446	--
18	Special arrangement of OHE under over line structure.	ETI/OHE/SK	529	--
19	Arrangement of overlap.	ETI/OHE/SK	566	-
20	Typical arrangement of OHE with insulated copper catenary under over line structure.	ETI/OHE/SK	570	--
21	Schematic arrangement of un-insulated over Lap(type-I) (3 & 4 Span overlaps).	RE/33/G	02121 Sh.1	F

Sl. No	Brief Description	Drawing		Mod. No.
		Series	Number	
22	Schematic arrangement of un-insulated overlaps (3 & 4 span overlaps).	ETI/OHE/G	02121 Sh.4	A
23	Schematic arrangement of insulated overlap.	ETI/OHE/G	02123 Sh.3	A
24	Schematic arrangement of insulated overlap.	ETI/OHE/G	02131 Sh.1	
25	General arrangement of regulated OHE at turn-outs (overlaps & crossed type).	ETI/OHE/G	02141	C
26	General arrangement of regulated OHE at cross over (overlap & crossed type).	ETI/OHE/G	02151	-
27	Arrangement of neutral section.	ETI/OHE/G	02161 Sh.1	C
28	Arrangement of short neutral section.	ETI/OHE/G	02161Sh.2	-
29	Arrangement of neutral section assembly (PTFE Type) at SWS.	ETI/OHE/G	02162	-
30	Standard termination of OHE (Regulated & un-regulated).	ETI/OHE/G	03121 (All parts).	E
31	General arrangement of connections to OHE by copper cross feeder (150).	ETI/OHE/G	05121 Sh.1	C
32	General arrangement of connections at switching station on double track section by copper cross feeder.	ETI/OHE/G	05122 Sh.1	C
33	General arrangement of connections at switching station on multiple track section by copper crossfeeder.	ETI/OHE/G	05123 Sh.1	C
34	Arrangement of suspension of double spider 25 kV feeder and return feeder between sub-station and feeding station.	RE/33/G	05152	C
35	General arrangement of earth wire on OHE mast.	ETI/OHE/G	05201	A
36	Arrangement of transverse bonds.	ETI/OHE/G	05251	A
37	Suspension of 25kV feeder on OHE mast	ETI/OHE/G	05143	B
38	Standard span Height Gauge for level crossing (for clear span above 7.3 m up to 12.2 m)	TI/DRG/CIV/ HGAUGE/-HR/RDSO	00002/20/0	-
39	Standard span Height Gauge for level crossing (for clear span up to 7.3 m)	TI/DRG/CIV/ HGAUGE/-HR/RDSO	00001/20/0	-

Appendix-7

List of CORE Drawings

(The listed Drawings of CORE are indicative and demonstrate the level of information and general description. The Equipment Support Structure and Foundations shall be designed as per the application duty requirement and the thermo dynamic stresses as may be witnessed by the equipment while operations or the Short Circuit Faults. The Manufacturer recommended Drawing will prevail subject to the local application duty, environment condition, soil bearing capacity and Insulation Coordination.)

Sl. No.	TITLEOFDRAWINGS	DRAWINGNO.
1	Structural layout of 132/25 kV traction sub-stations.	ETI/C/0200, SH.No.-1 (Mod-H); SH.No.-2 (Mod-D)
2	Typical cable trench and foundation lay out of 132/25kv TSS.	ETI/C/0210 (Mod. F)
3	Line Diagram of Structural layouts of 220/25kV Traction sub-station.	ETI/C/0222
4	Structural layout of 220/27kV traction sub-station (Type-I).	ETI/C/0222-I
5	Characteristics of conductors/ bus bar for 25kV AC traction.	ETI/OHE/G/05600 (Mod. A)
6	Typical earthing, cable trench & foundation layout of 132/25kv TSS.	ETI/PSI/ 224 (Mod. E)
7	Typical layout of Remote Control cubicle at a switching station.	ETI/PSI/0010 (Mod. E)
8	Typical location plan and general arrangement for a feeding station.	ETI/PSI/006 (Mod. E)
9	Typical return current connection to buried rail at 132/25kv Traction sub-station.	ETI/PSI/0212-1(Mod. NIL)
10	Typical layout for 25kv Shunt capacitor with series reactor to be installed at 132/25kv TSS.	ETI/PSI/0223 (Mod. E)
11	Typical general arrangement of earth screen wire termination at Traction substation.	ETI/PSI/0225 (Mod. C)
12	Typical schematic diagram of protection for single transformer traction sub-station.	ETI/PSI/0228-1 (Mod-NIL)
13	High speed auto reclosing scheme for feeder circuit breaker at 25kV A.C TSS.	ETI/PSI/0231-I (Mod A)
14	Typical layout of 132 /27kV traction substation (Type-I).	ETI/PSI/0230-1 (Mod. NIL)
15	Typical schematic diagram of protection for double Transformer traction substation.	ETI/PSI/024-1 (Mod. NIL)
16	Typical return current connection to buried rail at 132/25kV Traction sub-station.	ETI/PSI/0242 (Mod. A)

Sl. No.	TITLEOFDRAWINGS	DRAWINGNO.
17	Typical general arrangement of earth screen wire termination at 132/25kV traction sub-station.	ETI/PSI/0244
18	Typical earthing layout of a feeding station	ETI/PSI/203 (Mod. B)
19	Typical earthing arrangement for equipment/ structure at TSS.	ETI/PSI/228 (Mod-A)
20	Schematic inter connection diagram for remote control of power gear & supervision equipment at TSS.	ETI/PSI/644 (Mod. C)
21	Schematic inter connection diagram for remote control of power gear and supervision equipment at controlled station (SP & SSP).	ETI/PSI/645 (Mod. C)
22	General scheme of supply for 25 kV 50 Hz single phase AC traction system.	ETI/PSI/702-1 (Mod. D& E) &
23	Control desk arrangement for 2 work stations of SCADA system.	ETI/PSI/SK/337
24	Arrangement of suspension of double spider 25kV feeder and return feeder between substation and feeding station	RE/33/G/05152 (Mod. C)
25	Standard plan of control room at traction sub-station (General arrangement and RCC details)	RE/Civil/S-144/06
26	Typical schematic diagram for TSS, FP, SSP and SP with 21.6 MVA or 30 MVA transformers for three lines.	TI/DRG/PSI/3L-TSS/RDSO/00001/ 07/1 (Mod-NIL)
27	Typical layout of Control Room at traction sub-station.	TI/DRG/PSI/CPROOM/RDSO/ 00001/01/0
28	Typical layout of 132 /27kV Traction sub-station.	TI/DRG/PSI/TSSLO/RDSO/ 00001/01/0

Appendix-8

SPECIFICATION FOR 60/84/100 MVA, 132 kV/55 kV SCOTT-CONNECTED TRACTION POWER TRANSFORMER FOR 2x25 kV AT FEEDING SYSTEM

1 Scope

1.1 This document applies to 60/84/100 MVA, ONAN/ONAF/OFAF, 220/132/55kV Scott-connected traction power transformers for Auto Transformer (AT) feeding system for installation in HORC, an infrastructure providing company.

1.2 The transformer shall be complete with all parts, fittings and accessories whether specifically mentioned herein or not, necessary for its efficient operation in an unattended traction substation and it shall be supplied with appropriate fire fighting system as per IS-3034:1993 or with Nitrogen Injection Fire Protection system as per safety guidelines 2010 issued by CEA.

2 Governing specification

2.1 In the preparation of this document, assistance has been taken from the following National and International standards, wherever applicable.

Table No. 2.1-1

Standard		Description
Equivalents	IS	
IEC 60076 (all parts)	IS:2026 (all parts)	Power transformers.
IEC 62695		Traction Transformers
IEC 60044-1	IS:2705	Instrument transformer – Part 1: Current transformer.
IEC 60137	IS:2099	Bushing for alternating voltages above 1000V
IEC 60214	IS:8468	Tap changers.
IEC 60296	IS:335	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear/ New insulating oils.
	IS:5	Colours for ready mix paints and Enamels.
IEC 60502-1	IS:1554 (Part 1)	PVC insulated (heavy duty) Electric cables: Part 1 For working voltages up to and including 1100V
	IS:1570	Schedules for Wrought Steels - Part 5: Stainless and heat resisting steels.

	IS:1576	Solid pressboard for electrical purposes
IEC 60422	IS:1866	Code of practice for electrical maintenance and supervision of mineral insulating oil in equipment
	IS:2927	Brazing alloy
JIS C 2553	IS:3024	Grain oriented electrical steel sheets and strips
	IS: 3637	Gas operated relays
	IS:3639	Fittings and accessories for power transformers
	IS:4253	Cork composition sheets : Part 2 Cork and Rubber
	IS:5561	Electrical power connectors
IEC 60909	IS:13234	Guide for short circuit calculations in 3Phase a.c. systems.
IEC 60270	IS: 6209	High-voltage test techniques - Partial discharge measurements.
	IS:6600	Guide for loading of oil-immersed transformers
	IS:10028 (all parts)	Code of practice for selection, installation and maintenance of transformers
	IS:10593	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis
IEC 60137	IS: 12676	Oil impregnated paper insulated condensers bushings –dimensions and requirements
	DIN 7733	Laminated products, pressboard for electrical engineering, types.
		Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010, part-III, Sec.4, 2010 Rule no. 44 (2) (ix).
	IS-3034	Code of practice for fire safety of industrial buildings

2.2 In case of any conflict between the contents of the above standards and this document, the latter shall prevail.

2.3 Any deviation, proposed by the bidder, calculated to improve the performance, utility and efficiency of the equipment, will be given due consideration; provided full particulars of the deviation with justification are furnished. In such a case, the bidder shall quote according to this document and the deviations, if any, proposed by him shall be quoted as alternative/alternatives.

3 Climatic and Atmospheric Conditions

3.1 The transformer shall be suitable for outdoor use in moist tropical climate and in areas the limiting weather conditions which the equipment has to withstand in service are given in Clause 4.2 of chapter — 4 of this Specification.

3.2 The transformer would also be subjected to vibrations on account of trains running on nearby railway tracks.

3.3 The amplitude of these vibrations which occur with rapidly varying time periods in the range of15 to 70 ms lies in the range of 30 to 150 microns at present, with instantaneous peaks going up to 350 microns. These vibrations may become more severe as the speeds and loads of trains increase in future.

4 Traction Power Supply Systems 2x25kV AT Feeding System

4.1 General Scheme

4.1.1 The electric power for railway traction is supplied in ac 50 Hz, single-phase through 2x25 kV AT feeding system, which has a feeding voltage (2x25 kV) from the traction substation (TSS) two times as high as the catenary voltage, which is 25 kV with respect to earth/rail. The powerfed from the TSS through catenary and feeder wire is stepped down to the catenary voltage by means of autotransformers (ATs) installed at TSS/SP/SSP/ATS and then fed to the locomotives. In other words, both the catenary and feeder voltage are, 25 kV with respect to the earth/rail, although the substation feeding voltage between catenary and feeder wires is 50 kV. The catenary voltage is therefore, the same as that in the conventional 25 kV system.

4.1.2 The power supply shall be obtained from the 220/132 kV, three-phase, effectively earthed transmission network of the Power Supply Authorities of Haryana to the Scott-connected transformer installed atthe TSS, whose primary winding is connected to the three phases of the transmission network. The spacing between adjacent substations is normally 60 km.

4.1.3 One outer terminal of the secondary windings of the traction transformer is connected to the catenary and the other outer terminal is connected to the feeder.

4.1.4 ATs connect the 25 kV catenary to 25 kV return feeder, with mid-point connected to rail and earth (25 kV return OHE and earth). Two adjacent AT's share power to feed trains at 25 kV/2x25 kV system feeds 50 kV supply from traction transformer terminal to the ATs. The load current (current drawn by electric locomotives) from the TSS flows through the catenary and returns to the TSS through the feeder. For a train in an AT-cell (distance between two consecutive ATs), most of the current is fed to the electric locomotive by the ATs of that AT- cell; the, current returns in the rails/earth and is boosted up to the feeder through the neutral terminals of the autotransformers. The current in OHE, therefore, is an algebraic sum of 25 kVcurrent feed to locomotives from AT and the 50 kV supply to ATs from the TSS.

4.1.5 Approximately midway between adjacent TSSs, a sectioning and paralleling post (SP) is provided. In order to prevent wrong phase coupling of power supply, a dead zone known as 'Neutral Section' is provided in the OHE opposite to the TSS as well as SP.

4.1.6 For maintenance work and keeping the voltage drop within limit, one or more sub-sectioning and paralleling post (SSP) are provided between the TSS and SP.

4.2 Protection System

4.2.1 The protection system of the traction transformer comprises of the following:

1	Differential protection
2	Instantaneous and IDMT over-current, and earth fault protection on the primary side
3	Protection against phase-failure on the secondary side (i.e. to detect malfunction of feeder/transformer circuit breaker)

4	Buchholz Relay
5	Thermistor/Optical hot spot sensor. The Transformer should have built-in hottest spot temperature device to indicate and record the hot test spot temperature as per IEC-60076-2 (Ed. 3.0).

4.2.2 The protection systems for the OHE comprise the following:

1	Distance protection
2	Delta I type fault selective protection
3	Instantaneous over current protection
4	Under-voltage protection to avoid wrong phase coupling
5	Fault locating expert system based on AT voltage neutral current.

4.3 OHE General data

4.3.1 The OHE shall consists of (i) Contact wire of minimum 150 mm^2 cross section suspended directly from catenary of wire of minimum 120 mm^2 cross section by a number of vertical dropper wires, usually at regular intervals and (ii) a feeder wire of stranded all aluminium conductor.

4.4 Traction Transformer General Data

4.4.1 The transformer shall have 60/84/100 MVA power rating based on ONAN/ ONAF/OFAF cooling.

4.4.2 Contractor shall traction transformers complete with cooling fans for operation in ONAF mode (84 MVA), along with all controls and accessories.

4.4.3 Contractor shall supply traction transformers with oil pump foroperation in OFAF mode (100 MVA), along with all controls and accessories.

4.5 Nature of traction loads and faults on the OHE system

4.5.1 The traction load is a frequently and rapidly varying one; between no load and overload. The TSS equipment is subject to frequent earth faults/short circuits caused by failure of insulation, snapping of OHE touching earth, wire dropped by bird connecting the OHE to earth/ over line structure, and miscreant activity. On an average, the number of faults/ short circuits permonth could be as high as 40. The magnitude of the fault current may vary between 40% and 100% of the dead short circuit value. These faults are cleared by the feeder circuit breaker on operation of the distance, delta I and instantaneous over-current relays associated with the concerned feeder circuit breaker. In 2x25 kV system faults can occur with: feeder-earth; feeder-OHE and OHE-earth faults or a combination of them.

4.6 Short-Circuit Apparent Power of the system

4.6.1 The short-circuit apparent power at the transformer location for various system voltages is asunder:

Highest system voltage (kV) Um	Short circuit apparent power (MVA)
72.5	3,500
123	6,000
145	10,000
245	20,000

4.7 Auxiliary power supplies at TSS

4.7.1 The following auxiliary power supplies are available

1	110V dc from a battery
2	240 V ac, 50 Hz, single-phase from a 25/0.24 kV auxiliary transformer feed from Traction supply.

5 Rating and General Data

5.1 The rating and general data of the transformer shall be as follows:

S.No.	Item	Description
1	Type	ONAN/ONAF/OFAF cooled, Scott-connected (3 phase/ 2 phase), step down power transformer, double limb wound, core/shell-type for outdoor installation.
2	Windings	Primary windings shall be T-connected for three phase supply. Two secondary windings, one per phase, Main-phase (M-phase) and Teaser-phase (T-phase), with a phase difference of 90 degree. The primary and secondary windings shall be uniformly insulated.
3	Rated Frequency (Hz)	50 $\pm$ 3%
4	Rated 3-phase primary voltage between phases Un (kV)	220/132
5	Highest 3-phase system voltage between phases Um (kV)	245/145
6	Rated 2-phase secondary voltage (at no load), (kV)	55 per phase

7	Rated power, (MVA)	60/84/100 MVA ONAN/ONAF/OFAF (Each secondary winding shall have a rated power of 30/42/50MVA)
8	Rated current at the principal tapping: i. Rated primary current for Un 220kV in amps. ii. Rated primary current for Un132kV in amps iii. Rated secondary current (A)	 157.5/220.4/262.4 262.4/367.4/434.4 545/764/909 (for each secondary winding)
9	Percentage of impedance voltages, main/primary winding and teaser/primary winding at 30 MVA based at principal tapping.	%Z = 11-13%
10	Non-cumulative overload capacity on ONAN rating.	1) 150% rated load for 15 minutes 2) 200% rated load for 5 minutes
11	Polarity	Subtractive
12	Tapping (off - circuit)	Separate tapped winding on primary winding to give rated secondary voltage for variation in primary voltage of +10% to -15%, in steps of 5% each.
13	Temperature rise	1) Winding: 50K at rated load, and 60K for overloads as specified in Clause 5.1(10) (temperature measured by resistance method). 2) Top oil: 45K (temperature rise measured by thermometer). 3) Current carrying parts in air. 40K (temperature rise measured by thermometer).
14	Maximum permissible losses at principal tap	
	1. No-load losses, kW as per IEC 60076-1 clause 3.6.1	55 kW
	2. Total load losses at the principal tapping frame parts, tank and auxiliary requirements. As per IEC 60076-1 clause 3.6.3	275 kW at 60 MVA ONAN
	3. Total loss, kW as per IEC60076-1 clause 3.6.4	320 kW

<table>
<tr><td>15</td><td>Ability to withstand short circuit:
1.Thermal ability
2.Dynamic ability</td><td colspan="3">
2s
0.5s</td></tr>
<tr><td>16</td><td>Flux density at rated voltage and frequency at principal tapping.</td><td colspan="3">Shall not exceed either 1.7 T.</td></tr>
<tr><td>17</td><td>Current density in the windings.</td><td colspan="3">Shall not exceed 2.5A/mm^2 at 60MVA for ONAN.</td></tr>
<tr><td>18</td><td>Acoustic sound level when energized at rated voltage and at no-load.</td><td colspan="3">NEMA Standard TR-1-1993 (R2000) Table -2</td></tr>
<tr><td rowspan="6">19</td><td rowspan="6">Bushing</td><td>Item</td><td>Secondary</td><td>Primary
(220/132kV)</td></tr>
<tr><td>Type</td><td>OIP
condenser</td><td>OIP
condenser</td></tr>
<tr><td>Highest voltage for equipment Um (kV)</td><td>60</td><td>245/145</td></tr>
<tr><td>Rated current(A)</td><td>1250</td><td>800</td></tr>
<tr><td>Minimum creepage distance in air (mm)</td><td>1300</td><td>6125/3625</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="9">20</td><td rowspan="9">Busing type current transformers for differential protection of transformer</td><td>Item</td><td>Secondary</td><td>Primary</td></tr>
<tr><td>Highest voltage</td><td>60</td><td>245/145</td></tr>
<tr><td>CT Ratio</td><td>1000/5</td><td>300/5, 600/5</td></tr>
<tr><td>Frequency(Hz)</td><td>50 +/- 3%</td><td>50 +/- 3%</td></tr>
<tr><td>Class of accuracy as per IEC61869-1.</td><td>PX</td><td>PX</td></tr>
<tr><td>Minimum knee-point emf,(V)</td><td>150</td><td>125/175</td></tr>
<tr><td>Maximum excitation current at knee-point voltage (A)</td><td>0.25</td><td>0.75</td></tr>
<tr><td>Maximum resistance of the secondary winding, (Ω)</td><td>0.5</td><td>0.25</td></tr>
</table>

6 Salient design features

6.1 Overall dimensions

6.1.1 The overall dimensions of the transformer shall be kept as low as possible and in any case shall not exceed the transportation limit in India.

(Transportation dimension)

1	Length x Width (in mm)	14,000 x 6,500
2	Height of topmost point of primary bushing terminal	7,500 mm
3	Height of topmost point of secondary bushing terminal	5,500mm

6.1.2 The manufacture shall, where practical, design the transformer so that with the bushings & accessories removed, the transformer shall fit within Indian Railway loading gauge, in case it is transported through rail, MMD to be enclosed with the offer.

6.1.3 The transformer should be designed nitrogen or dry air filled, such that it can be transported without the insulation oil inside the tank. The transformer shall be designed such that it can betransported with tank under pressure with nitrogen and other protective measures that the Manufacturer recommends, so that no moisture can enters the housing.

6.2 Tank

6.2.1 The tank for the transformer shall be of the top cover jointed with bolted connection. The bottom plate of main tank shall be firmly welded to the main body and the top cover is a plate reinforced with ribs. The winding and core shall fully exposed when the tank cover is lifted. A pressure gauge along with a hygrometer shall be provided so that the status of dryness of the winding can be assessed in the transformer prior to its heat run before commissioning.

6.2.2 The tank shall be constructed from mild steel of a quality that allows welding without any defect/flaw, with a single tier construction, shaped so as to reduce welding to the minimum. The welded joints shall be made using good engineering practices. The tank shall be adequately strengthened for general rigidity to permit hoisting of the transformer filled with oil by crane. The tank body shall be designed to withstand against the full vacuum degree.

6.2.3 The tank shall be fitted with four lifting pads at the lower end to enable lifting of the transformer filled with oil by means of lifting jacks.

6.2.4 The tank shall be fitted with an under carriage and mounted on bidirectional swiveling type flanged rollers for being rolled on 1676mm gauge track, on which it shall also rest in the final position. The rollers shall be provided with detachable type locking arrangement to enable their locking after installing the transformer in the final position, to hold the transformer fixed on foundation and to prevent any accidental movement of the transformer.

6.2.5 There shall be at least five inspection covers of suitable size on the tank to enable inspection of the lower portions of bushings, and the leads as well as the various connections of the motorised off-circuit tap-changer.

6.2.6 The gaskets with groove NBR (NITRILE BUTADIENE RUBBER) shall be provided for oil sealing points. The rubberized cork gasket may be used for other general portion.

6.2.7 All valves used in the transformer shall be capable to withstand full vacuum degree. The manufacturer shall ensure that suitable anti-theft measures like locked use of blanking plates are provided on these valves, so as to prevent pilferage/theft of oil during transit and service.

6.3 Marshalling box

6.3.1 A vermin proof, weatherproof and well ventilated, marshalling box with IP class 55, made up of sheet steel of thickness not less than 2 mm, strengthened with adequate stiffeners, shall be provided on the left hand side of the transformer tank as viewed from the secondary terminals side.

It shall have a hinged door, with provision for padlocking the door opening outward horizontally.

6.3.2 The marshalling box shall have a sloping roof. The top of the marshalling, box shall be at a height of about 2 m from the transformer rail level.

6.3.3 The marshalling box, shall house the winding and oil temperature indicators and terminal board. To prevent condensation of moisture in the marshalling box, metal clad space heater controlled by an associated thermostat and switch shall be provided. Cable glands shall be provided for the incoming and outgoing cables.

6.3.4 The temperature indicators shall be so mounted such that their dials are at a height of not more than 1.6 m from the rail level. Transparent windows of tough acrylic plastic or similar non-fragile transparent material shall be, provided on the marshalling box, so as to enable reading of the temperature indicators without opening the door of the marshalling box

6.3.5 All cables from the bushing current transformers, Buchholz relay, magnetic oil level gauge, pressure relief device and, temperature indicators shall be run up to the marshalling box. The cables shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armored, stranded copper conductor conforming to IEC 60502-1. The cables shall, be adequately insulated for heat from the tank surface and the sun.

6.3.6 All wiring in the marshalling box shall be clearly identified by lettered/figured ferrules of the interlock type, preferably of yellow colour with-black letters/figures. The ac and dc circuits shall be clearly distinguished and well separated from each other.

6.3.7 Suitable legend and schematic diagram plates made of anodised aluminium with black lettering and lines shall be fixed on the inside surface of the marshalling box door.

6.4 Core

6.4.1 The core shall be built-up of high permeability cold rolled grain oriented silicon steel laminations conforming to JIS C2553 or equivalent IS as indicated in Table No. 2.1-1. The flux density in any part of the core and yokes at the principal tapping with primary winding excited at the rated primary voltage and frequency shall not exceed 1.7 T. The successful bidder / manufacturer shall furnish calculations to prove that this value shall not be exceeded.

6.4.2 The lamination for the core shall be free from waves, deformations and signs of rust. Both sides of the laminations shall be coated with suitable insulation capable of withstanding stress relief annealing. In assembling the core, air gaps shall be avoided. Necessary cooling ducts shall be provided in the core and yoke for heat dissipation. The core clamping frame shall be provided with lifting eyes for the purpose of tanking and un-tanking the core and winding of the transformer.

6.4.3 The core shall be electrically solidly connected to the tank.

6.4.4 Design of the Core shall be boltless and it shall be tightened by binding the laminations using resin glass tape. Core laminations shall be tested after completion of the core assembly to ensure that they withstand a voltage of 2 kV r.m.s with respect to core for duration of 60 seconds.

6.4.5 The transformer is required to be continuously in service, preferably without requiring any attention from the date of its energization, up to the periodical overhaul (POH), which is generally done after 10-12 years of service. The successful bidder/ manufacturer of the transformer shall, take this aspect into account during core assembly/manufacture and indicate measures taken by them to ensure suitable clamping to permit the above frequency and cover this in their instruction manual.

6.5 Windings

6.5.1 The winding shall be of disc/interleaved/inter-shield/rectangular pancake type for the primary and of disc/helical/cylindrical/rectangular pancake type for the secondary windings. The primary and secondary windings shall be uniformly insulated. All the four terminals of both secondary windings of 'M' and 'T' phases shall be brought out separately through 60 kV OIP condenser bushings, for cascade connection externally. The QAP of the manufacturing process is to be submitted along with the bid.

6.5.2 The workmanship shall be of high quality in keeping with Good Engineering Practices and as for insulation, insulating materials of class A or higher should only be used.

6.5.3 No joint shall be used in the winding conductor, in principle, except for inter-leave joint.

6.5.4 Separate tapped coil shall be provided for each primary winding for connection of the motorized off-circuit tap-changer. The tapped coils shall be distributed in multi-sections in order to reduce the imbalance in ampere turns to the minimum at any tap position.

6.5.5 Separate tapped winding shall be provided for each primary winding. The transformer windings shall be designed for the following rated withstand voltages:

SN	Item	Secondary	Primary (132kV)
1	Highest voltage for equipment Um(kV)	60	245/145
2	Rated short duration power frequency withstand voltage (kV)	115	395/275
3	Rated lightning impulse withstand voltage (kV peak)	280	950/650

6.5.6 The windings shall be so designed that the transfer of lightning and switching surges from primary to secondary windings and vice-versa is kept to the minimum level.

6.5.7 The axial pre-compression on the windings shall not be less than the double the calculated axial thrust that may be set up under dead short-circuit condition so; as to ensure that the windings do not become loose due to frequent short circuits in service.

6.5.8 During short circuits, the stresses set up in conductors, spacers, end blocks, clamping, rings and such other parts of the transformer; shall not exceed one third of the maximum permissible values.

6.5.9 Pre-compressed spacers shall be used between disc shaped coils of the windings to transmit the axial forces generated due to the short circuits.

6.5.10 A uniform shrinkage shall be ensured during the drying of the individual coils or assembly of coils by providing a uniform clamping force with the help of hydraulic jacks or similar devices.

6.5.11 In order to keep unbalanced axial force due to non-uniform shrinkage/unequal height of the coils to the minimum, wedges of pre-compressed wood or similar such material shall be used.

6.5.12 The successful bidder/ manufacturer shall ensure that there is no further shrinkage of the coil assembly in any additional cycle after the final curing.

6.5.13 The separate winding compression structure suitable shall be provided apart from the core clamping structure in order to not causing any loose. The equal axial force compression system shall be applied on to each assembled windings throughout the drying process and fixing with the high tension self-tightening structure to eliminate any loose unbalanced face due to non-uniform shrinkage of windings. To prevent displacement of the radial spacers usedin the windings, closed slots shall be provided.

6.5.14 The vertical locking strips and slots of the radial spacers shall be so designed as to withstand the-forces generated due to short circuits.

6.5.15 The vertical locking strips and radial spacers shall be made of pre-compressed pressboard conforming to grade PSP: 3052 of DIN 7733.

6.5.16 To prevent end blocks from shifting, pre-compressed pressboard ring shall be provided in between the two adjacent blocks. Coil clamping rings made of densified wood or mild steel shall be located in position with pressure screws.

6.5.17 Leads from the windings to the terminals, from the tap switch to the tappings of the primary windings and other interconnections shall be properly supported and secured.

6.5.18 The following particulars/ documents in respect of the radial spacer blocks (winding blocks), vertical locking strips (axial ribs), end blocks, insulating cylinder, angle rings, paper insulation of the conductor and coil clamping plates used in the manufacture of the windings shall be furbished.

1. Reference to specification-and grade of material.
2. Source(s) of supply,
3. Test certificates.

7 INSULATING OIL

7.1 The transformer shall be supplied with new insulating oil conforming to IEC60296. In addition, 10% extra oil by volume, shall be supplied in nonreturnable steel drums. The characteristicsof the insulating oil before energisation of service shall conform to IEC 60296.

8 BUSHINGS AND TERMINAL CONNECTORS

8.1 Both the primary and secondary side bushings shall conform to IEC 60137. On the primary, side, sealed draw lead type Oil Impregnated Paper (OIP) condenser bushings shall be used. On the secondary side, sealed solid stem type OIP condenser bushings shall be used.

8.2 The bushings shall have a non-breathing oil expansion chamber. The expansion chamber shall be provided with an oil level indicator, which shall be so designed and dimensioned that oil level is clearly visible from ground level.

8.3 A test tap shall be provided for dielectric or power factor measurement.

8.4 The bushings shall be designed for the following insulation level:

1	Highest voltage for equipment Um (kV)	60	245/145
2	Rated short duration wet power frequency withstandvoltage (kV)	115	460/275
3	Rated lightning impulse withstand voltage (kV peak)	280	1050/650

8.5 Adjustable arcing horns shall be provided on both the primary and secondary bushings. The horn gap setting shall be variable as indicated below:

1.	Highest voltage for equipment Um, kV	60	245/145
2.	Horn gap setting variable between, mm	150 and 300	1200 and 1500, 500 and 900

8.6 The design and construction of the bushing shall be such that stresses due to expansion and contraction in any part of the bushings shall not lead to its deterioration breakage. The bushings shall be free from corona and shall not cause radio interference.

8.6 The bushing terminals shall be provided with terminal connectors of bimetallic type and shall be such that there is no hot spot formation even during the extreme over load condition of ONAN rating with 200% over loading.

8.7 The terminal connectors shall conform to IS: 5561. The design shall be such as to be connected to the equipment terminal stud with a minimum of four 12 mm diameter bolts, nuts, spring and flat washers.

9 BUSHING TYPE CURRENT TRANSFORMERS

9.1 The 60 kV and 245/145 kV bushings shall be so arranged as to accommodate bushing type current transformers (BCTs) for the biased differential protection of the transformer. The BCTs shall conform to IEC 61869-1 and meet with the stipulations in Clause 5.1(20) of this document.

9.2 The BCTs shall be so designed as to withstand thermal and mechanical stresses resulting from frequent short circuits experienced by the transformer on which these are fitted.

9.3 Apart from the BCTs required for the biased differential protection, BCT of accuracy class 5 and conforming to IEC 61869-1, with suitable tappings, shall be mounted inside one bushing of the left-hand side (as viewed, from the. secondary; terminals, side) of each secondary winding 'M' and 'T' phases for use with the-winding temperature indicators.

9.4 The BCTs and the bushings shall be so mounted so that removal of a bushing can be achieved without disturbing the current transformers, terminals and connections or pipe work is easy and convenient.

9.5 The leads from the BCTs shall be terminated in terminal boxes provided on the bushing turrets. Suitable links shall be provided in the terminal boxes for shorting the secondary terminals of the BCTs, when not connected to the external measuring circuits.

9.6 The leads from the secondary winding of the BCT terminated in the terminal box on the bushing turret up to the marshalling box shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armoured, stranded copper cable of cross section not less than 4 mm^2 to IEC 60502-1.

9.7 Cable glands of proper size shall be provided in the terminal boxes to lead in/lead out the cables.

10 CLEARANCES

10.1 The relative orientation in space of the bushings fitted with terminal connectors the main tank, radiators, conservator, pressure relief device, oil piping and other parts when mounted on the transformer shall be such that the various clearances in air from bushing live parts shall notbe less than the appropriate values given here under:

1	Highest voltage for equipment Um(kV)	60	245/145
2	Minimum clearance (mm)	500	1900/1200

The same distance shall apply for clearances phase-to-earth (including oil piping work, conservator, pressure relief device and such other parts), phase-to-phase and towards terminals of a lower voltage winding.

11 MOTORISED OFF-LOAD TAP-CHANGER

11.1 The transformer shall be fitted with a motor operated off-circuit rotary type tap-changer, to cater for the voltage, range specified in Clause 5.1(12) of this document. Visibility of the tap position should be such that display is legible. The motor drive unit shall be installed in a weather and corrosion proof adequately ventilated cubicle made of sheet steel not less than 2 mm thick with adequate stiffeners to prevent deformation during transit and handling. The cubicle shall have a sloping roof. The top of the cubicle shall be at a height of about 1.5 m from the rail level. The cubicle shall be so positioned that the hinge of the operating handle formanual operation is at a height of about 1.1 m from the rail level.

11.2 To prevent condensation of moisture in the cubicle, metal clad space heater, controlled by an associated thermostat and switch, shall be provided.

11.3 All wiring in the cubicle shall be clearly identified by lettered/figured ferrules of the interlock type, preferable of yellow colour with black letters/figures. The ac and dc circuits shall be clearly distinguished and well separated from each other.

11.4 Suitable legend and schematic diagram plates made of anodised aluminium with black lettering and lines shall be fixed on the inside surface of the cubicle door.

11.5 A tap position indicator shall be provided to indicate the tap position which shall be clearly visible to an operator standing on the ground.

11.6 The tap-changer motor shall be suitable for operation of 110 V DC from a battery. The voltage at the battery terminals may vary between 110% and 85% of the normal value. The voltage at the tap-changer motor terminals is likely to be less than 85% of the normal value of 110 V DC due to voltage drop in control cable.

11.7 .The circuit for the tap changer motor shall be such that the rollers does not get struck between the two taps should the 110V DC supply to the motor fails.

11.8 The tap-changer shall be provided with suitable interlocking arrangement to prevent its operation (including manual tap changing) when either one or both circuit breakers on the primary as well as on the secondary sides of the transformer is/are in closed condition.

11.9 The tap-changer and its control circuit shall be designed for operation with SCADA from the Operation Control Centre (OCC) by the Traction Power Controller (TPC) as well as from the tap-changercubicle. A local/remote switch as well as necessary terminations for tele signals and tele commands from and to the tap-changer-for-operation from the RCC-shall, therefore, be provided in the tap-changer cubicle.

12 Cooling Equipment

12.1 The transformer shall be designed to be ONAN/ONAF/OFAF Cooled. The transformer shall be designed such that in case of emergency feed extension, it shall be capable of delivering 40% more of the ONAN rating with forced cooling and 100 MVA with oil pumps in operation.

12.2 The fans shall be designed with 50% redundancy.

12.3 The fans shall be fitted with fan failure alarms. These alarms shall be routed back to the marshalling box, for connection to the SCADA system. There shall be visual indication in the marshalling box as to which fan group has failed.

12.4 The radiators shall consist of a pressed steel plate assembly formed into elliptical oil channels as per IEEMA Standard. The radiators shall be designed in such a manner that the temperature-rise limits specified under Clause 5.1 (13) of this document are not exceeded.

12.5 The radiators shall be removable (after isolating the same from the main tank) to facilitate transportation of the transformer. A drain plug of size 19 mm and an air-release plug of size19 mm shall be provided at the bottom and at the top of each radiator bank for draining and filling of oil respectively. Each radiator bank shall also be provided with shut-off valves. If radiators are supplied as a separate unit, then body bellows type flexible joints shall be provided on the oil headers.

12.6 The radiators shall preferable be supported directly on the transformer tank. Each radiator bank shall be fitted with lifting lugs.

13 Parts, Fittings and Accessories

13.1 Apart from the parts, fittings and accessories specifically detailed in the foregoing Clauses, the parts, fittings and accessories detailed hereunder shall be supplied with each transformer.

13.1.1 Conservator Tank: It shall be of adequate capacity and complete with supporting bracket or structure, oil filling cap and drain valve of size 25 mm. The cylindrical portion of the conservator tank shall be of single piece construction without any gasket joint. Suitable air cell/separator arrangement of high quality material shall be provided in the conservator to ensure that the transformer insulating oil does not come in contact with air. The material of cell/separator shall be quoted fabric consisting of highly resistant polyamide fabric, externally coated with perfectly transformer oil resisting coating (chemical), inner coating resisting ozone & weathering. Suitable instructions may be provided for installation/commissioning & future maintenance of air cell/separator arrangement**.**

13.1.2 **Oil Level Gauge**: It shall be of magnetic type having a dial diameter of 200 to 250 mm. The gauge shall have markings corresponding to minimum oil level, maximum oil level and oil level corresponding to oil temperature of 30^{o}C, 45^{o}C and 85^{o}C. The oil level indicator shall be so designed and mounted that the oil level is clearly visible to an operator standing on the ground. The oil level gauge shall be fitted with two SCADA readable contacts. The first contact shall provide a warning that the oil level is at 25% above the minimum level. The second contact shall indicate when the minimum oil level has been reached.

13.1.3 **Silica Gel Breather**: It shall be complete with oil seal and connecting pipes. The connecting pipes shall be secured properly. The container of the silica gel breather shall be of transparent flexi glass or similar material suitable for outdoor application.

13.1.3.1. Orange silica gel (round balls 2 to 5 mm) with quantity of two DT-8 silica gel connecting with flanged mounting two pipes control through different valves as per DIN: 42567 & IS: 6401 to be provided.

13.1.3.2. **Pressure Relief Device**: It shall be designed to operate to release internal pressure at pre-set value without endangering the equipment or operator and shall be of instantaneous reset type. Shroud Pressure Relief Device will be used and have provision of discharge of oil from PRD to safe place by closed pipeline. This avoid hazards of fire and it is safe to persons working near Transformer & it is environment friendly.

13.1.4 **Filter Valves**: The bottom and upper filter valves shall be of 50 mm size and suitably baffled to reduce aeration of oil. The valves shall be flanged to seat 40 mm adopter threaded to thread size P 1-1/2 for connection to oil filtration plant.

13.1.5 **Drain Valve**: It shall be of size 80 mm fitted with an oil sampling device of size 15mm.

13.1.6 **Earthing Terminals**: Two earthing terminals of adequate size shall be provided on the tankfor its earthing with the help of 3 mild steel flats, each of size 75 mm x 8 mm. The terminals shall be clearly marked for earthing.

13.1.7 **Buchholz Relay**: It shall be of double float type, with two shut-off valves of 80 mm size, one between the conservator tank and the Buchholz relay and the other/between the transformer tank and the Buchholz relay. The relay shall have one alarm contact and one trip contact, none of the contacts being earthed. The contacts shall be of mercury/micro switch type, electrically independent and wired up to the marshalling box. A testing petcock shall be brought down through a pipe for the purpose of sampling the gas, if any, collected in the Buchholz relay.

13.1.8 **Oil temperature indicator (OTI)**: It shall have one alarm contact, one trip contact and two normally open spare contacts none of the contacts being earthed. The contacts shall be electrically independent.

13.1.9 **Winding temperature indicator (WTI)**: Two WTIs shall be provided, one for the M-phase and the other for the T-phase. Each WTI shall have one alarm contact, one trip contact and two normally open spare contacts, none of the contacts being earthed. The contacts shall be electrically independent. The windings shall also be fitted with analogue temperature sensors/thermistors/opticalsensors that are suitable for being remote read via the SCADA system.

13.1.10 **Thermometer Pockets**: A separate thermometer pocket with cap shall .be provided on the tank for measuring the top oil temperature in the tank. The thermometer shall indicate hot spot temperature.

13.1.11 **Rating Plate**: The rating plate shall indicate the following:

- The ratings of the transformer
- The connection diagram of the windings
- The particulars of the bushing current transformers
- Weight without oil
- Weight with oil
- Kind of transformer (I.e. Scott Connected traction transformer)
- Manufacturer
- Date of manufacture
- Serial number
- Rated Voltages in (kV) and tapping range
- Rated primary and secondary currents

- Short circuit impedance
- Type of cooling
- Other details as per IEC 60076-1.

The rating plate shall be both in English and Hindi version.

13.2 All valves shall be of the double flange type and fitted with suitable blanking plates on theouter face of the exposed flange.

13.3 The capillary tubes for temperature indicators shall be able to withstand normal bending. Theyshall be supported properly without sharp or repeated bends or twists.

13.4 Fibre Optic Hot Winding Temperature Monitor:

Fibre optical winding hot spot temperature monitor to be provided with the transformer windings, connected in addition to the winding temperature indicator in parallel to measure transformer winding hot spots in real time and activate control of the cooling system. The fibre to be given high strength casing through rugged jacketing and fibre to be securely routed till the tank wall plate. The application of fibre optic shall be governed by IEC-60076-2 (Ed. 3.0).

<u>Specification for Fibre Optic Temperature Measurement System</u>

Fibre optic based temperature measurement of Oil and windings shall be done using FibreOptic Sensors meetings following broad criteria:

13.4.1 System shall be of proven technology. The temperature sensing tip of the fiber optic shall be ruggedized. The probes shall be directly installed in each winding of power transformer to measure the winding hot spot and at the top oil temperature. There shall be at least 4 probes inside the transformer.

13.4.2 Out of the 4 probes, one probe shall be used for top oil temperature measurement, one for HT winding and balance two for LV windings.

13.4.3 Probes shall be able to be completely immersed in hot transformer oil. They shall withstand exposure to hot vapour during the transformer insulation drying process, as part of Vacuum Phase Drying (VPD). The probes shall meet the requirement to eliminate the possibility of partial discharge in high electric stress areas in the transformer. Probes shall preferably have certified Weidman testing for electrical parameters as per ASTM D-3426 and ASTM D-149 that is current (no more than 1 year old). Test results and studies to be submitted by the transformer manufacturer along with the first unit of a certain type of traction power transformer.

13.4.4 Temperature range of the system should be up to +200°C without any need of recalibration. Probes must connect to the tank wall plate with threaded connectors containing a Viton O-ringto prevent against oil leakage.

13.4.5 Probes shall be of material inert to mineral and ester oils, multiple jacketed (Kevlar preferred), perforated out jacket to allow complete oil filling and mechanical strength.

13.4.6 System should include analog outputs for each measurement channel. Temperature resolution of the analog outputs shall be ±0.1°C and precision of ±0.5°C and the system shall offer user programmable temperature alarm outputs with 8 relays. The cooling system (Fans & Pumps) should be operated through these relays. The temperature settings for the relays shall be made as per the end-user request.

13.4.7 All inputs and outputs of the system shall meet the requirements of surge test of IEEE C37.90.1-2002. The system should electronically store testing records of components and allow for on board diagnostics and instructions, including a signal strength reading to verify integrity of fiber optic connections. System should contain a battery for date/time stamp of data readings. The system should comply with IEC61850 protocol, along with DNP 3.0, Modbus, TCP/IP and ASCII.

13.4.8 The transformer manufacturer should submit details showing that the probes are located in the hottest point of the winding, while submitting drawings for approval. The manufacturer arefree to use more than 4 probes if design so required.

13.4.9 The controller shall be housed in cooler cubicle or in a separate enclosure having ingress protection IP 56.

13.4.10 Temperature Rise Test Measurements shall be made with the Fiber Optic Thermometers.

13.4.11 The equipment shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identifiedand temperature data for all probes recorded and reported in the test report.

13.5 The manufacturers of Part, Fittings & Accessories for the transformer shall be mentioned inthe SOGP/BOM & got approved. During prototype test, the accessories will be tested & performance monitored by either at Customer Hold Point (CHP) or by Test Certificate (TC) Verification. Henceforth, while ordering Traction Power Transformer, a copy of Employer approved SOGP should be called by the users. This document shall form basis for ordering accessories in the future.

In case manufacturers desire to change a particular make of accessory, prior approval of Employer would be required and SOGP as well as Bill of Material (BOM) shall have to be got approved from Employer.

In case of make of accessories approved under Customer Hold Point (CHP) for regular production, the Employer's approval would be required separately on SOGP and BOM. The Traction Power Transformer manufacturer shall be responsible for availability of compatible accessories for the equipment approved.

14 Fasteners

14.1 All fasteners of 12 mm diameter and less exposed to atmosphere shall be of stainless steel and those above 12 mm diameter shall preferably be of stainless steel or of, mild steel hot dip galvanised to 610 g/sqm of zinc. The material of the stainless steel fasteners shall conform to IS: 1570 (Part-V), Grade 04Cr17Ni12Mo2 or equivalents.

15 PAINTING

15.1 Shot blasting/ sand blasting shall be done on the transformer tank to remove all scales rust and other residue, before applying the paint inside the tank. All steel surfaces which are in contact with insulating oil shall be painted with heat resistant oil-insoluble insulating varnish. All steel surfaces exposed to weather shall be given, one primer coat of zinc chromate and two coats of anti-corrosion grey paint. The touch-up of gray paint shall be applied at site by, the manufacturer.

16 TESTING OF TRANSFORMER

16.1 General

16.1.1 The designs and drawings of transformer together with detailed calculations & the Quality Assurance Plan (QAP) shall be furnished to the Employer, within the period stipulated in the contract. Only after all the designs and drawings as well as the QAP have been-approved for prototype tests and a written advice given to that effect, shall the successful bidder/manufacturer take up manufacture of the prototype of the transformer. It is to be clearlyunderstood that any change or modification required by the above authorities to be done in the prototype shall be done expeditiously, notwithstanding approval having already been given for the, designs and drawings. Such change or modification shall be incorporated in the drawings.

16.1.2 Prior to giving a call to the Employer for inspection and testing of the prototype, the successfulbidder/manufacturer shall submit a detailed test, schedule consisting of schematic circuit diagrams, for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. In case any dispute or disagreement arises between the successful bidder/manufacturer and representative of the Employer during the process of testing as regards the procedure for typetests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the Employer, as the case may be, whose decision shall be final and binding. Only after the prototype transformer is completed and ready in each and every respect, shall the successful bidder/manufacturer give the actual call for the inspection and testing.

16.1.3 The type tests shall be carried out on the prototype transformer at the works of the successful bidder/manufacturer or at reputed testing laboratory in the presence of the representative of the Employer, in accordance with the relevant specifications and as modified or amplified by this document.

16.2 Tests during manufacture

16.2.1 Though the tests described below shall form part of the type tests, the manufacturer shall carry out these tests on each unit during the process of manufacture and submit the test reports to the Employer deputed for witnessing the routine tests:

- Oil leakage test.
- Vacuum test.
- Pressure test.
- Test for pressure relief device.
- Measurement of capacitance and tan-delta values.

16.2.1.1 **Oil Leakage Test**: The transformer with its radiators, conservator tank and other parts, fittings and accessories completely, assembled shall be tested for oil leakage by being filled with oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure corresponding to twice the normal static oil head or to the normal static oil head plus 35 kN/m^2 (0.35 kgf/cm^2) whichever is lower, the static oil head being measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hr, during which time no leakage shall occur.

16.2.1.2 **Vacuum Test:** The transformer tank only shall be tested at a vacuum of 3.33 kN/m2 (0.0333 kgf/cm2) for 60 minutes. The permanent deflection of flat plates after release of vacuum shall not exceed the values specified below:

Horizontal length of flat plate	Permanent deflection (mm)
Up to and including 750mm	5.0

751mm to 1250mm	6.5
1251mm to 1750mm	8.0
1751mm to 2000mm	9.5
2001mm to 2250mm	11.0
2251mm to 2500mm	12.5
2501mm to 3000mm	16.0
Above 3000mm	19.0

16.2.1.3 Pressure Test: Every transformer tank, radiator and conservator tank shall be subjected to an air pressure corresponding to twice the normal static head of oil or to normal static oil head pressure plus 35 kN/m^2 (0.35 kgf/cm^2) whichever is lower as measured at the base of the tank. The pressure shall remain constant for 1 hour to indicate that there is no leakage.

16.2.1.4 Test of Pressure Relief Device: Every pressure relief device shall be subjected to gradually increasing oil pressure. It shall operate before the pressure reaches the test pressure specified in Clause 16.2.1.3 hereof and the value; at which it has operated shall be recorded.

16.2.1.5 Measurement of capacitance and Tan-Delta values: The measurement of capacitance and tan-delta (dielectric loss factor) of the transformer windings shall be made by Schering Bridge.

16.3 Type Tests

16.3.1 General

The type tests shall be carried out on' the prototype transformer at the works of the successful bidder/manufacturer or at any reputed laboratory in the presence of the representative of the Employer and in accordance with the relevant specifications and as altered, amended or supplemented by this document. Amongst others, the following shall constitute the type tests:

1) Temperature-rise test

2) Lightning impulse test.

3) Test with lightning impulse stopped on the tail

4) Short circuit test.

5) Measurement of acoustic sound level.

6) Measurement of partial discharge quantity.

7) Measurement of harmonics of no-load current.

16.3.2 Temperature-rise test:

16.3.2.1 The temperature rise test shall be done with the tap changer on the lowest tap position (-15%). in accordance with IEC60076-2 except as modified hereunder.

1	At rated load at ONAN, ONAF & OFAF rating.
2	At 150% rated load for 15min after continuous operation at rated load for 1hour at ONAN rating.
3	At 200% rated load for 5 minutes after continuous operation at rated load for onehour at ONAN rating.

The tests shall be done continuously without any power supply interruption. In case interruptions of power supply do take place for some reason, then the entire test shall: be repeated after steady state conditions are attained.

The points to be ensured during the temperature rise test shall be:

1	The ambient temperature shall be measured using calibrated thermometers only
2	The winding temperature shall be determined by the resistance method only.
3	The temperature of the top oil shall be measured calibrated thermometer placed in an oil-filled thermometer pocket.
4	The average oil temperature shall be calculated as the difference between the topoil temperature and half the temperature drop in the cooling equipment (radiators)
5	The temperature of the hot-spot in the winding shall be the sum of the temperature of the top oil and 'H' times the temperature rise of the winding above the average oil temperature, where 'H' is the hot spot factor as per IEC 600076-2 and 60076-7.

16.3.2.2 The test shall be carried out as described below:

16.3.2.2.1 100% load

1	A quantum of power equal to the sum of the measured losses viz. no-load and load losses measured at minus 15% tap position,/corrected to 75^{0}C plus 10% of such sum shall be fed to the primary winding of the, transformer with the secondary windings short-circuited.
2	The power so fed to the transformer shall be continuously maintained till such time as the steady stats temperature is reached i.e. the top oil temperature rise does not vary by more than 1^{0}C during four consecutive hourly readings
3	On attaining the steady state temperature, the current in the primary winding of the transformer shall be brought to the rated current which shall-be maintained for one hour. At the end of the period the power supply to the transformer shall be switched off and the time of Switching off recorded.

4	The measurement of resistance shall commence as soon as is possible after switching off. The first reading of the resistance shall be taken as soon as possible, before the expiry of 90 seconds from the instant of switching off and the first ten readings shall be taken at intervals of l5s apart. Thereafter, another ten readings shall be taken at intervals of 30s apart.
5	The time at which each of the resistance values is read shall also be recorded.
6	The temperatures of the ambient, top oil, the top and bottom radiator header oils shall also be recorded at half-hourly intervals throughout the test starting from the instant power supply is; switched on to commence the if test till it is switched off.
7	The WTI and OTI readings shall also be recorded at half hourly intervals right from the instant the power supply is switched on to commence the test till it is switched off
8	After power supply is switched off the readings of OTI and WTI shall be recorded atintervals of 1 min apart for 30 minutes.

16.3.2.2.2 150% load

1	After completion, of the test at 100% load, the transformer shall be fed with power which shall be a value so as to cause circulation of the rated current in the primary, winding with secondary windings short circuited. This current shall be circulated for 1hour.
2	The current shall thereafter be increased to 150% of the rated current and maintained-for a" period of 15min. At the end of the 15 min period the power supply shall be switched off and the time of switching off recorded.
3	Thereafter, the readings as indicated in Clause 16.3.2.2.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top oil, the top and bottom radiator header oil and the temperatures indicated by OTI and WTI shall also be recorded at the time of switching on 150% load as well as at the time of switching off the power supply.

16.3.2.2.3 200% Load

1	After completion of the test at 150% load, the transformer shall be fed with power which shall be a value so as to cause circulation of rated current in the primary with the secondary windings short circuited. This current shall be circulated for 1hour.
2	The current shall thereafter be increased to 200% of the rated current and be maintained for 5minute period. At the end of the 5minute period the power supply shall be switched off and the time of switching off recorded.
3	Thereafter the readings as indicated in clause 16.3.2.2.1(4) to (8) shall be recorded.

4	The temperatures of ambient, top-oil, top and bottom radiator header oils and temperatures indicated by OTI and WTI shall also be recorded at the time of switching on the 200% load as well as the time of switching of the power supply.

16.3.2.3 **Determination of thermal time constant of the windings**: The thermal time constant of the primary and secondary windings under both rated load and overloads shall be verified during the temperature rise tests.

16.3.2.4 The temperature rise of the oil, windings and current carrying parts in air under both the overload conditions stipulated in clauses for 150% load and 200% load above shall not exceed the values stipulated in clause 5.1(13) of this document. The windings hot-spot temperature under the overload conditions shall not exceed 115^{0}C.

16.3.2.5 **Testing and calibration of the temperature indicators**: The functioning of the OTI and WTI shall be verified during the tests described above. Both the OTI and WTI shall be recalibrated, where necessary, to reflect the respective temperatures correctly. In particular, the reading of the WTI shall be the same as the calculated value of the hot-spot temperature of the winding.

16.3.2.6 **Determination of the thermal time constant of the WTI**: The thermal time constant of the WTI shall be determined for comparison with the thermal time constant of the windings of the transformer, with respect to the transformer oil. For this purpose, the indications of the WTI and the OTI shall be recorded every minute during the first 1 hour from the instant the transformer is loaded. From the slope of the curve plotted with time on the x-axis and the difference between the readings of the WTI and the OTI at particulartime on the y-axis, the thermal time constant of the WTI shall be determined.

16.3.3 Lightning Impulse Test

16.3.3.1 This test shall be done in accordance with IEC 60076-3. Each of the terminals of the primary and secondary windings shall be tested with the following:

1	Highest voltage for equipment Um (kV)	60	245/145
2	Lightning impulse withstand voltage (kV peak)	280	950/650

16.3.4 Test with lightening impulse, chopped on the tail

16.3.4.1 This test shall be done in accordance with IEC60076-3 with appropriate test voltage as stipulated in Clause 16.3.3.1 above.

16.3.5 Short Circuit Test

16.3.5.1 The short circuit test shall be conducted in accordance with IEC 60076-5 with the following schedule:

1. Insulation resistance of the windings with respect to the earth and the windings.
2. No load current
3. No load loss
4. Resistance of windings
5. Percentage impedance voltages.

6. Load loss

7. Voltage ratio

8. Di-electric test comprising:

   - Separate source voltage withstand test
   - Induced over voltage withstand test

9. Recording of Surge frequency Response Analysis (SFRA) at the highest (+10%),lowest (15%) and principal tapping as per IEC 60076-18.

16.3.5.2 The short circuit test may be performed either from the secondary side or the primary side. However, test protocol need to be finalized with prior approval of the Employer.

16.3.5.3 The transformer shall be subject to a total of seven shots in the following sequence:

1st Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at highest tap (+10%)
2nd Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the highest tap (+10%)
3rd Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at principle tap
4th Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the principle tap
5th Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at lowest tap (-15%)
6th Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the lowest tap (-15%)
7th Shot	Symmetrical currents in M-phase and T-phase at lowest tap (-15%)

16.3.5.4 The duration of each shot shall be 0.5s

16.3.5.5 Measurements shall be done after each shot for the following:

1	Percentage impedance voltage
2	No-load current
3	No-load loss

16.3.5.6 Further testing and inspection of the transformer subjected to the short-circuit test shall be carried out as per IEC 60076-5 with the modification that:

1	The dielectric routine tests shall be at 100% of the original test value
2	The percentage impedance voltages measured after the short circuit test shall not vary by more than 2% from those measured before the sort circuit test.

16.3.5.7 On completion of the short circuit test the transformer shall be un-tanked for inspection of the core and windings. In case the inspection of the core and windings do not reveal any apparent defects and the results of the short circuit test, the values of percentage impedance voltages as also the results of the route tests done after the short circuit test are in order the transformer will be deemed to have passed the short circuit.
If any of the results of the tests are not in order or the inspection of the core andwinding reveals any defects, then the transformer shall be dismantled for detailed inspection.

16.3.6 Measurement of acoustic sound level

16.3.61 Measurement of acoustic sound level of the transformer energized at rated voltage and frequency shall be carried out as per IEC60076-10.

16.3.7 Measurement of Partial discharge quantity

16.3.7.1 Partial discharge quantity of the windings shall be measured in accordance with IEC 60076-3.

16.3.8 Measurement of harmonic of no-load current.

16.3.8.1 The magnitude of harmonics of no-load current, as expressed in percentage of the fundamental, shall be measured by means of a harmonic analyser, in accordance with IEC 60076-1.

16.3.7 Test with lightening impulse, chopped on the tail:

16.3.7.1 This test shall be done in accordance with IEC 60076-3 with appropriate test voltage as stipulated in Clause 16.3.3.1 above.

16.4 Type tests on parts, fittings and accessories

16.4.1 Tests for motorized off circuit tap changer

16.4.1.1 Though there are no Indian Standards Specifications at present for motorized off-circuit tap-changer, the following test shall be carried out thereon in accordance with IEC 60214.

16.4.1.2 **Tests for temperature rise of contacts**: The test shall be carried out at rated current. The temperature rise shall not exceed the limit specified in IEC 60214.

16.4.1.3 **Mechanical endurance test**: With the tap changer in oil, 1000 operations shall be done manually. An operation shall comprise moving the tap changer from one tap position to the next higher or low tap position. All the taps of the tap changer i.e. 10% position tap through to the 15% tap shall be covered during the test.

16.4.1.4 **Milli Volt drop tests**: The test shall be done both before and after the mechanical endurance test to access the condition of contacts. The variation in millivolt drop values shall not be more that 20%.

16.4.1.5 **Short Circuit current test**: The test shall be done in accordance with IEC60214 with short circuit currents of 4 kA rms, each 5s duration.

16.4.1.6 **Dielectric tests**: The test shall be done in accordance with IEC 60214.

16.4.2 Condenser Bushings

16.4.2.1 The type tests shall be carried out in accordance with IEC 60137 on porcelain housing of the condenser bushings. The following shall constitute the type test:

1. Visual inspection
2. Verification of dimensions
3. Electrical routine test

4. Porosity test
5. Temperature cycle test
6. Bending test

16.4.2.2 The type tests shall be carried out in accordance with IEC 60137 on prototype of the condenser bushing. The following shall constitute the type test:

1. Wet power frequency withstand voltage test
2. Dry lightning impulse voltage test
3. Thermal stability test
4. Temperature rise test
5. Thermal short time current withstand test
6. Cantilever load withstand test
7. Tightness test
8. Test of tap insulation
9. Tightness at flange or other fixing device
10. Measurement of partial discharge quantity.

16.4.3 Bushing type current transformers

16.4.3.1 The bushing type current transformers shall be tested in accordance with IEC61869-1.

16.4.4 Buchholz relay

16.4.4.1 The Buchholz relay shall be tested in accordance with IS: 3637

16.4.5 Terminal connector

16.4.5.1 The terminal connectors shall be tested in accordance with IS: 5561

16.4.6 Temperature indicators

16.4.6.1 The following tests shall be conducted on prototypes of OTI and WTI:

1	Accuracy with reference to a standard instrument
2	Calibration of the indicators to reflect the actual temperature of the oil/ windings
3	Dielectric test at 2.5kV for 60s.
4	Vibration test.
5	Dust and water splash test to IP55 degree of protection.

16.4.7 Pressure Relief Device

16.4.7.1 The following tests shall be conducted on the prototype of the pressure relief device:

1. Air pressure test.
2. Leakage test
3. Contact rating and operation test
4. Dielectric test on contacts at 2.5 kV for 60s.

16.4.8 Radiators

16.4.8.1 The radiators shall be tested for air leakage at a pressure of 2.5 kg/cm^2. The pressure shall remain constant for 1h to indicate that there is no leakage.

16.5 Insulating Oil

16.5.1 The following tests shall be carried out in accordance with IEC60296 on the sample of new insulating oil for use in the prototype transformer:

1. Density at 27 ^{0}C
2. Kinetic viscosity at 27 ^{0}C
3. Interfacial tension at 27 ^{0}C
4. Flash point.
5. Neutralisation value (acidity)
6. Electric strength (with 2.5mm gap)
7. Dielectric dissipation factor (tan-delta)
8. Specific resistance at 27 ^{0}C and at 90 ^{0}C
9. Oxidation stability
10. Water content.

16.6 Routine tests

16.6.1 The following routine tests shall be undertaken on each transformer including the prototype unit in accordance with IEC 60076-1:

1. Visual examination
2. Insulation resistance measurement
3. Measurement of no load current
4. Measurement of no load loss
5. Measurement of resistance of the windings
6. Measurement of percentage impedance voltages
7. Measurement of load loss
8. Polarity test
9. Voltage ratio test.

10 Dielectric tests comprising:
- Separate-source voltage with stand test
- Induced over voltage with stand test.

11 Recording/ submission of SFRA as per IEC 60076.

12 Recurrent Surge Oscillogram (RSO) Test

13 Test for motorized off circuit tap changer

16.6.2 **Visual examination**: A general examination shall be made to check that the transformer conforms to the approved drawings, various items are accessible for maintenance, the quality of workmanship and finish are of acceptable standards and all parts, fittings and accessories\are provided.

16.6.3 **Insulation resistance test**: The insulation resistance of the windings with respect to the earth and between the windings shall be measured using a 5 kV Megger.

16.6.4 **Measurement of no-load current**: Measurement of no load current referred to the primary side shall be done at:

1. 90%, 100% and 110% of the rated voltage at the principal tapping, and

2. The appropriate tap voltage at the +10% and -15% tap positions.

16.6.5 **Measurement of no-load loss**: Measurement of no-load loss referred to the primary, side shall be done at:

1. 90%, 100% and 110% of the rated voltage at the principal tapping, and
2. The appropriate tap voltage at the +10% and -15% tap positions.

16.6.6 **Measurement of resistance of windings**: The resistance of the windings shall be measured at all tappings and computed at 75^0C.

16.6.7 **Measurement of percentage impedance voltages**: The percentage impedance voltages at 'principal', +10% tap and -15% tap positions shall be measured at rated current and at ambient temperature and computed at 75^0C.

16.6.8 **Measurement of load loss**: Load losses at rated current shall be measured at principal, +10% and -15% tap positions at ambient temperature and computed at 75^0C.

16.6.9 **Polarity test**: The polarity (subtractive) and marking of the terminals for the polarity shall be verified.

16.6.10 **Voltage ratio test**: Voltage ratio shall be measured at all tap positions.

16.6.11 **Dielectric tests**:

16.6.11.1 **Induced over voltage withstand test**: The test shall be done by applying the test voltage across the entire secondary winding as per IEC 60076-3.

16.6.12 **Separate source voltage withstand test**: The test voltage to be applied as under:

1	Highest voltage for equipment Um (kV)	60	245/145
2	Rated short duration power frequency withstandvoltage (kV)	115	460/275

16.6.12.1 Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18.

16.6.13 **Tests on off-load tap-changer**: The tests shall be conducted in accordance with IEC 60214.

16.6.14 During the routine tests of any unit if it is found that the sum of the measured losses (i.e. no-load and load losses) measured at the principal tapping (corrected to 75^0C) exceeds the maximum guaranteed value defined in Clause 5.1 (14), the transformer shall be rejected.

16.7 If the prototype of a transformer conforming to this document and rating has already been approved in connection with previous supplies to Indian Railways, fresh type testing may be waived at the discretion of the Employer, provided that no changes whatsoever in the design or materials used or the process of manufacture have been made.

However, the Employer reserves the right to conduct type tests, if he deems, it necessary to do so in the light of experience gained from previous supplies.

16.8 Only after approval of the original tracings of drawings incorporating changes, if any, as a result of the prototype tests and clear written approval of the results of. the tests on the prototype is communicated by the Employer, to the successful bidder/manufacturer, shall take up bulk manufacture of the transformer which shall be strictly with the same materials and process of manufacture as adopted for the prototype. In no circumstances shall materials other than those approved in -the design/drawings and/or during the prototype testing be used for bulk manufacture-on the plea that they had been obtained prior to the approval of the prototype.

16.9 Transformer before dispatch should be filled with Nitrogen/ dry air and provided with a gauge clearly visible for monitoring the pressure inside the tank.

17 TECHNICAL DATA

The following shall be furnished by the Tenderer:

17.1 Calculations for:

1. Temperature rise of winding at rated current.
2. Hot-spot temperature of the winding at 150% and 200% rated loads for 15 min and 5 min respectively.
3. Thermal withstand capacity of the windings for a short circuit of 2 s duration.
4. Mechanical forces in respect of the following as per IEEMA (Indian Electrical & Electronic Manufacturer's Association) formulae:
    a) Asymmetrical short-circuit current.
    b) Hoop stress in primary and secondary windings.
    c) Compressive pressure in the radial spacers.
    d) Internal axial compressive force.
    e) Axial imbalance force.
    f) Radial bursting force.
    g) Resistance to collapse.
    h) Bending stress on clamping ring and densified wood.
    i) Maximum allowable torque on pressure screws for coil clamping bolts at the timeof tightening, if any.
5 Flux density with the characteristic curve.
6 Maximum value of inrush current.

17.2 Drawings for:

1. Outline general arrangement drawing giving complete details of the transformer.
2. Arrangement of the core, windings and magnetic path.
3. Magnetizing characteristic of CRGO sheet steel.

17.3 The successful bidder/ manufacturer shall submit to employer for approval the following detailed dimensioned drawings as per Indian Railways standard in sizes of 210 mm x 297 mm (A4) or any integral multiples thereof.

1. Outline general arrangement of the transformer indicating plan, front elevation, side elevation with all parts, fittings and accessories, electrical, clearances as well as salient guaranteed particulars.
2. Internal arrangement of the transformer indicating primary and secondary bushing lead connections, core to clamp to core-base bolting, and the locking arrangement of the core assembly with the tank.
3. Cross sectional view of the core and windings with material specifications and makes.
4. Detail of the pressure screws/oil dash-pot/coil clamping bolts or other devices andtheir location with materials specification.
5. Schematic view of the valves used on the transformer and the anti theft device so asto prevent theft of oil.

6. Transport outline dimensions.
7. General arrangements of the odd-circuit tap changer assembly with salient technical parameters.
8. Tap changer cubical layout.
9. Schematic diagram for driving of motorized off circuit tap changer via SCADA.
10. Name and rating plate of motorised off circuit tap changer.
11. General arrangement of marshalling box indicating protection and control equipment.
12. Wiring diagram of the marshalling box.
13. Schematic diagram of protection and control circuits in marshalling box with cableschedule.
14. Legend plate showing protection and control circuits for fitment into the marshallingbox.
15. OIP condenser bushing for primary side including cross-sectional view, shed profileand salient electrical and mechanical characteristics.
16. OIP condenser bushing for secondary side including cross-sectional view, shed profile and salient electrical and mechanical characteristics.
17. Dimensional drawing, V-I characteristic and rating plate for bushing type current transformers.
18. Rigid terminal connectors for primary side bushing terminal
19. Rigid terminal connectors for secondary side bushing terminal
20. Rating plate with diagram of connections, both in English and Hindi versions.
21. Details of radiators
22. Details of breather
23. External cable-run with cable schedule.
24. Any other drawings which the successful bidder considers necessary.

17.4 After approval, six copies of each of the approved drawings along with two sets of reproducible prints for each drawing shall be supplied to each consignee(s).

17.5 Two copies of the "Operations and Maintenance manual" for each transformer shall besupplied to the consignee(s) two copies of the manual shall be supplied to the Employer.

18 Spares

18.1 The bidder shall supply the following essential spares for every lot of up to 5 of 220/132kV transformers or part thereof.:

1. One primary bushing complete with parts, fitting and bushing type current transformer.
2. One secondary bushing complete with parts, fitting and bushing type current transformer.
3. One complete set of gaskets of all sizes required for use in the transformer.
4. One breather unit with silica gel.
5. One piece of radiator.
6. One each of terminal connectors for primary and secondary side bushing terminals
7. One set of valves
8. One pressure relief device.
9. One set of primary, secondary and tapping coil
10. One complete off circuit motorized tap changer

19 ERECTION, TESTING AND COMMISSIONING

19.1 The transformer shall be erected and commissioned by the successful bidder. The manufacturer shall invariably make available at site the services of an engineer to ensure, by his continued presence, that the process of erection, testing and commissioning of the transformer is in accordance with established and recommended practices. For this purpose, prior intimation regarding the dates/period and locations at which the transformers are to be erected and testing/commissioning done shall be given by the bidder to the manufacturer.

20 SCHEDULE OF GUARANTEED PERFORMANCE, TECHNICAL AND OTHER PARTICULARS (GUARANTEED PARTICULARS ARE TO BE ESTABLISHED BY ACTUAL TESTS/ TEST REPORTS) (TT)

SN		DESCRIPTION	UNIT OF MEASUREMENT	VALUE/ INFORMATION
1		2	3	4
A		**RATINGS/PARTICULARS**		
1.		Name of the Manufacturer		
2.		Country of manufacture		
3.		Reference to specification based on which performance data is prescribed		
4.		Rated power	MVA	
5.		Primary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
6.		Secondary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
7.		Rated voltage :		
		a) Primary	kV	
		b) Secondary (at no-load)	kV	
8.		Rated frequency	Hz	

9.		Temperature rise above ambient temperature of 50 ^{0}C :		
	(i).	Oil :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
	(ii)	Winding :		
		a) At rated load ^{0}C		
		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
10		Hot-spot temperature of winding over ambienttemperature of 50°C	^{0}C	
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
		Interval of time between two successive overloads after continuousworking at full load, at maximum ambient temperature of 50°C:		
		a) Between two consecutive over loads of 50%for 15 min	min.	
		b) Between two consecutive min overloads of which one is of 50% for 15 min and the other of100% for 5 min.	min.	
11		No-load current referred to primary side at rated frequency and at:		
		a) 90% rated voltage	A	
		b) Rated voltage	A	
		c) 110% rated voltage	A	
12		Power factor of no-load current at rated voltage and rated frequency		
13		Value of the inrush current at rated voltage on primary side, the secondary side being opencircuited		
14		Losses:		
	(i)	No-load loss at rated frequency and at:		
		a) 90% rated voltage .	kW	
		b) rated voltage .	kW	
		c) 110% rated voltage .	kW	
			kW	

			kW	
	(ii)	Load loss (at 75 ^{0}C) at rated current and frequency	kW	
			kW	
			kW	
			kW	
	(iii)	Total losses at rated current and frequency	kW	
			kW	
			kW	
			kW	
15		Resistance voltage (at 75 ^{0}C) at rated current	%	
16		Reactance voltage (at 75 ^{0}C) at rated currentand frequency	%	
17		Impedance voltage (at 75 ^{0}C) at rated currentand frequency	%	
18		Resistance (at 75 ^{0}C) of primary winding	ohm	
19		Resistance (at 75 ^{0}C) of secondary winding	ohm	
20		Reactance of winding :	H	
	i)	Primary at Principal tapping	H	
	ii)	Primary at + 10% tapping	H	
	iii)	Primary at – 15 % tapping	H	
	iv)	Secondary	H	
			H	
21		Regulation (at 75 ^{0}C) with rated current and at power factor of:		
		a) Unity	%	
		b) 0.8 lagging	%	
22		Efficiencies:		
	(i).	Efficiency (at 75 ^{0}C) at unity power factor at:		
		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(ii).	Efficiency (at 75^{0}C) at 0.8 power factor lagging at:		

		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(iii)	Percentage of rated load at which maximumefficiency occurs.	%	
23		Ability to withstand short-circuit:		
		a). Thermal	s	
		b). Dynamic	s	
24		Thermal time constant (calculated):		
	(i)	for winding with respect to oil at:		
		a). rated current	min	
		b). 150% rated current	min	
		c). 200% rated current	min	
	(ii)	Complete transformer at rated current	min	
25		Temperature gradient between oil and winding		
		at:		
		a). Rated current	^0C	
		b). 150% rated current for 15 min	^0C	
		c). 200% rated current for 5 min.	^0C	
26		Temperature rise of oil:		
	(i).	Calculated average temperature rise of oil at:		
		a). Rated current	^0C	
		b). 150% rated current for 15 min	^0C	
		c). 200% rated current for 5 min	^0C	
	(ii)	Estimated temperature rise of top oil at:		
		a). Rated current	^0C	
		b). 150% rated current for 15 min	^0C	
		c). 200% rated current for 5 min	^0C	
27		Details of core:		
	(i)	Type of core		
	(ii)	Flux density at rated voltage and frequency	tesla	

	(iii)	Flux density at 110% rated voltage and frequency	tesla	
	(iv)	Thickness of steel stampings	mm	
	(v)	Grade of core material and conforming specification		
	(vi)	Exciting VA/kg for core stampings at:	50 Hz	
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	VA/kg	
	(vii)	Exciting VA/kg for assembled core at:	50 Hz	
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	VA/kg	
	(viii)	Type of insulation between core laminations.		
	(ix)	Type of joint between the core limbs and yoke.		
	(x)	Core bolt Insulation withstand voltage	kV	
	(xi)	Core bolt insulation flashover voltage	kV	
28		Details of windings:		
	(i)	Type of winding		
		(a) Primary		
		(b) Secondary		
		(c) Number of turns of primary winding		
		(d) Number of turns of secondary winding		
		(e) Number of parallel paths in primary winding		
		(f) Number of parallel paths in secondary winding.		
		(g) Is interleaving/inter shielding of the winding adopted to ensure better impulse voltage distribution?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(h) Is the insulation of end turns of winding reinforced?	Yes/No	
		(i) Primary		
		(ii) Secondary		

		(i) Type of coil		
	(ii)	Mode of connection (i.e. in series or in parallel) of the portions of thewindings on the two limbs of the core, if applicable.		
	(iii)	Dimensions of the copper conductor used in the winding:		
		a) Primary	mm x mm x No. of Cond.	
		b) Secondary	mm x mm x No. of Cond.	
		c) Tapped winding.	mm x mm x No. of Cond.	
	(iv)	Current density at rated current.		
		a) Primary	A/mm^2	
		b) Secondary	A/mm^2	
	(v)	Insulation used over the conductor (details ofmaterial and specification there for)		
	(vi)	Type of joints, if any, in the windings		
	(vii)	Dielectric strength of windings:		
		a) Full wave lightning impulse withstand voltage:		
		i) Primary winding	kV peak	
		ii) Secondary winding.	kV peak	
		(b) Lightning Impulse chopped on the tail withstand voltage:	kV	
		(i) Primary winding	kV	
		(ii) Secondary winding	kV	
		(c) Separate source power frequency withstandvoltage	kV	
		(i) Primary	kV	
		(ii) Secondary	kV	
		(d) Induced over voltage withstand value	kV	
	(viii)	Minimum flashover distance to earth in oil of :		
		a) Secondary winding to core	mm	
		b) Primary winding to yoke	mm	
		c) Primary winding to tank	mm	

	(ix)	Material used for coil clamping rings and specification there for		
	(x)	Magnitude of axial pre-compressive force on the winding		
		(a) Primary	kgf	
		(b) Secondary	kgf	
	(xi)	Calculated maximum axial thrust in the windingdue to dead short circuit at the terminals		
		(a) Primary	kgf	
		(b) Secondary	kgf	
	(xii)	Calculated short circuit forces:		
		a) Hoop stress in primary winding	kgf/cm^2	
		b) Hoop stress in secondary winding	kgf/cm^2	
		c) Compressive pressure in the radial spacers	kgf/cm^2	
		d) Internal axial compressive force	kgf/cm	
		e) Axial imbalance force	kgf	
		f) Resistance to college	kgf	
		g) Bending stress on clamping	kgf/cm^2	
		h) Radial bursting force	kgf	
	(xiii)	Arrangement to maintain constant pressure on the windings		
	(xiv)	Maximum permissible torque on pressure screws for coil clamping at the time of tightening, if any.	N.m	
	(xv)	Can either end of each secondary winding (25kV) be connected directly to earth?	Yes/No.	
29		Bushings:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation (specify as to whether it is OIP condenser bushing)		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	

		h) Wet one minute power frequency withstandvoltage	kV	
		i) Lightning impulse withstand voltage	kV peak	
		j) Creepage distance	mm	
		k) Weight of assembled bushing	Kg	
	(ii)	Secondary side		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstandvoltage	kV	
		i) Lightning impulse withstand voltage	kV peak	
		j) Creepage distance	mm	
		k) Weight of assembled bushing	kg	
30		Bushing type current transformers:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ratio		
		d) Accuracy class and rated accuracy limit factor		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C	ohm	
		j) Short time thermal current and duration.	kA, s	
	(ii)	Secondary side:		
		a) Name of the manufacturer		

		b) Governing specification		
		c) Transformation ration		
		d) Accuracy class		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C.	ohm	
		j) Short time thermal current and duration	kA, s	
31		Insulating oil :		
		a) Governing specification		
		b) Grade of oil		
		c) Source of supply		
		d) Specific resistance at:		
		i) 27 ^{0}C	ohm-cm	
		ii) 90 ^{0}C	ohm-cm	
		e) Dielectric, dissipation factor (tan-delta) at 90 ^{0}C-		
		f) Dielectric strength	kV	
		g) Water content	ppm	
		h) Interfacial tension	N/m	
		i) Neutralisation value	mg KOH/gm	
		j) Flash point	°C	
32		Type of transformer tank		
33		Details of radiators:		
		a) Make and type		
		b) Type of mounting		
		c) Overall dimensions (LxWxH)	mmx mm x mm	
34		Details of Buchholz relay:		
		a) Make and type		
		b) Governing specification		

		c) Provision of shut-off valves on either side ofthe relay	Yes/No	
		d) Provision of alarm contact	Yes/No	
		e) Provision of trip contact	Yes/No	
		f) Rated current of contacts	A	
35		Details of winding temperature		
		Indicator.		
		a) Make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
36		Details of oil temperature indicator		
		a) make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
37		Details of Magnetic oil level gauge:		
		a) Make and type		
		b) Governing specification		
		c) Diameter of dial	mm	
		d) Number of contacts provided		
		e) Rated current of contact	A	
		f) Dielectric withstand value of contacts	kV	
38		Details of pressure relief device:		
		a) Make and type		
		b) Governing specification		
		c) Does it reset itself	Yes/No	
39		Bimetallic terminal connectors:		
	(i)	Primary side:		
		a) Source of supply		
		b) Governing specification		

		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45°C while carrying rated current.	°C	
		f) Short time current and duration	kA, s	
	(ii).	Secondary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambienttemperature of 45^0C while current rated current	°C	
		f) Short time current and duration	kA, s	
40		Acoustic sound level at a distance dB of 1 m, when energised at rated voltage and ratedfrequency without load.		
41		Partial discharge value at 1.5Um/ 3 kV r.m.s.	pC	
42		Weights and dimensions:		
	(i)	Net weight of core	kg	
	(ii)	Net weight of cooper:	kg	
		a) Primary winding	kg	
		b) Secondary winding	kg	
	(iii)	Net untanking weight of core frame and coils	kg	
	(iv)	Net weight of insulating oil	kg	
	(v)	Volume of insulating oil	l	
	(vi)	Total weight of cooling equipment	t	
	(vii)	Total weight of transformer without oil	t	
	(viii)	Total shipping weight of complete transformer including all detachable parts, fittings andassemblies	t	
	(ix)	Shipping weight of largest package	t	
	(x)	Crane lift (excluding slings) for un-tanking coreand coils	mm	
	(xi)	Crane lift (excluding slings) for removal of primary side bushings.	mm	

	(xii)	Dimensions of the complete transformer including all parts, fitting andaccessories:		
		a) Overall length	mm	
		b) Overall breadth	mm	
		c) From rail level to the topmost point	mm	
	(xiii)	Minimum thickness of steel plate/ sheet used:		
		a) tank cover mm		
		b) Tank bottom mm		
		c) Conservator mm		
		d) Radiator mm		
		e) Marshalling box. Mm		
	(xiv)	Overall shipping dimensions of the largest package (Length x width x height)	mm x mm x mm	
	(xv)	Mode of transportation of transformer unit (filled with oil/nitrogen gas.)		
		Other particulars		
43		Is the transformer tank fitted with lifting pads? Ifyes, what is the number of pads	Yes/ No	
44		What is the number of inspection covers provided?		
45		Are comfits/ trays provided for cable run?	Yes/ No	
46		Is the core electrically connected with the tank?	Yes/No	
47		Will the gaskets to be used in the transformer give trouble free service for at least 7 years? If not, indicate the life.	Yes/No	
48		Is the core construction without core bolts?	Yes/No	
49		Are the core bolts grounded, and if so, how?	Yes/ No	
50		What is the number of radial spacers used in the winding?		
51		What is the number of joints provided in the winding?		
52		Are the spacers/blocks/angle rings of pre-compressed press boards? Ifno, indicate the material with specification.		
53		Are arrangements made for ensuring automaticconstant pressure on the coils? If no. give the reasons.	Yes/ No	
54		Are closed slots provided on outer most winding for locking the vertical strips? If no, give the reason.	Yes/ No	

55		What is the periodicity for tightening of coil clamping arrangement?	Years	
56		What are the designed values of short-circuit current for:		
		a) Symmetrical :		
		i) Primary winding	A rms	
		ii) Secondary winding A	A rms	
		b) A symmetrical:		
		i) Primary winding A	A peak	
		ii) Secondary winding A	A peak	
57		What is the over flux withstand capability of the transformer (Maximum permissible limit of flux density) ?	Tesla	
58		Are windings pre-shrunk?	Yes/No	
59		Have the details of drying cycles of the coils/coil assembly including final tightening values of pressure, temperature and degree of vacuum at various stages of drying been furnished?	Yes/ No	
60		Are arcing horns provided for line and neutralbushings?	Yes/ No	
61		Is a test tap provided in the line bushing?	Yes/ No	
62		Is the porcelain housing of the bushings of single piece construction?	Yes/ No	
63		Is the shed profile of porcelain housing of thebushing free from under-ribs but has a lip?	Yes/ No	
64		Is the bushing type current transformer of lowreactance type?	Yes/ No	
65		Is Clause by Clause "Statement of compliance"attached?	Yes/ No	
66		Is "Statement of deviation", if any, attached?	Yes/ No	
67		Deleted		
68		Deleted		
69		Are fasteners of 12 mm diameter and less exposed to atmosphere of stainless steel to Grade 04Cr17 Ni12Mo to IS 1570 Part-V?	Yes/ No	

70		Are the fasteners of more than 12 mm diameterexposed to atmosphere of stainless steel orMS hot dip galvanised?	Yes/ No	
71		Are test certificates for tests as per Clause 15.0attached?	Yes/ No	
72		Are all the calculations required as	Yes/ No	
73		Are all the drawings required as per clause 16.3.2 attached?	Yes/ No	
74		(a) Are all the parts, fittings and accessoriesfrom Employer's approved manufacturers?	Yes/ No	
		(b) If not, list the items which are to be type tested in the presence of Employer's representative.	Yes/No	
75		Is adequate space provided in the marshallingbox for housing the wiring and components?	Yes/ No	
76		Deleted		
77		Is the list of spares furnished or no?		

Enclosed:

- **Annexure – 1**, Technical Specification for Nitrogen Injection Fire Prevention and Extinguishing System for Oil Filled Transformer.
- **Annexure – 2**, Technical Specification for Fibre optic Winding Hot Spot Temperature Monitor.

****

Annexure - 1

TECHNICAL SPECIFICATIONS FOR NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM FOR OIL FILLED TRANSFORMER

1.0 GENERAL DESCRIPTION:

Nitrogen injection fire protection system designed for oil filled transformers shall prevent tankexplosion and the fire during internal faults resulting in an arc, where tank explosion will normally take few seconds after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion and/or external failures like busing fires, OLTC fires and fire from surrounding equipment's.

The system shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

Conservator tank oil shall be isolated during bushing bursting, tank explosion and oil fire to prevent aggravation of fire.

Transformer isolation shall be an essential pre-condition for activating the system. The system shall be designed to operate automatically. However, it shall be designed for manual operation, in case of failure of power supply.

The system shall consist of following equipment:

1. Fire extinguishing cubicle placed on a plinth at about 5-10 meter away from the transformer.
2. Control box placed in the control room.
3. Necessary valves in the conservator pipe.
4. Suitable fire sensing components to be provided preferably in/on the tank cover.
5. Signal box suitably placed.

2.0 SCOPE

The scope of this document covers design, engineering, supply testing at works before dispatch; erection, testing and commissioning and performance demonstration of "fire protection and extinguishing system by nitrogen injection method".

The necessary civil work which will be required for construction of oil soak — pit for the storage of oil coming out from the transformer and plinth for extinguishing cubicle is outside the scope of this document shall be provided by the Contractor executing the project). However, laying of oil pipe, nitrogen pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary vales, fire detectors and other equipment & accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the tenderer. It will be the responsibility of the tenderer, i.e. transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests. Notwithstanding the technical specifications and requirements mentioned herewith any modification can be incorporated for correct operation of nitrogen injection fire protection system without extra cost. The full details of the same are required to be submitted to Employer for approval, when first unit is implemented on a transformer of specific make & rating.

3.0 OPERATIONAL CONTROLS:

The system shall be provided with automatic control for fire prevention and fire extinction. Besides automatic control, remote electrical push button control on control box and local manual control in the fire-extinguishing cubicle shall be provided. The fire protection system will take signal from HV/LV circuit breaker.

4.0 SYSTEM ACTIVATING SIGNALS:

4.1 Transformer isolation shall be an essential pre-condition for activating the system. Provision shall be provided to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before Nitrogen injection and after oil depressurization.

4.2 There shall be two modes of operation of Fire Protection System i.e. Fire Prevention Mode & Fire Extinction Mode. In these mode the safety equipment to be involved are tabulated below. The logic of their operation shall be finalized during design approval.

Mode of Operation	Safety Equipment to be used
Fire Prevention Mode	• Differential relay/Over current/Restricted earth fault relay. • Pressure relief valve
Fire Extinction Mode	• Fire sensing components • Buchhloz relay

5.0 SYSTEM EQUIPMENT:

5.1 Fire Extinguishing Cubicle (FEC), placed on plinth at about minimum 5 meter away from thetransformer shall consist of:

5.1.1 Nitrogen gas cylinder with pressure reducer/regulator and falling pressure electrical contact manometer.

5.1.2 Oil drain pipe with mechanical quick drain valve;

5.1.3 Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.

5.1.4 Pressure monitoring switch for backup protection, pressure reducer with solenoid valve in the cabinet for operation of nitrogen gas release, which will be IP-65, protected and leak proof for nitrogen release.

5.1.5 Limit switches for monitoring of the system.

5.1.6 Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.

5.1.7 Panel lighting

5.1.8 Oil drain pipe extension of suitable sizes for connecting pipes to oil pit.

5.1.9 The Nitrogen gas cylinder should be of sufficient (not less than 50 liter) capacity and should be filled at a pressure of not less than 150 bars with falling pressure electrical contact manometer, suitable design measures to prevent leakage of gas to be taken.

5.1.10 The nitrogen valve shall have IP-65 protection. The nitrogen shall be contained within the cylinder and released from the cylinder valve only upon activation of the fire protection system. Nitrogen purity shall 99.99%

5.1.11 Proper approvals and certificates should be provided with each cylinder. No used nitrogen bottle will be accepted.

5.2 Control box with activating, monitoring devices and line faults indicators to be placed in control room. It should have audiovisual alarm indication and push button switches for tests response.

5.3 Necessary valves to be fitted in the conservator pipeline between conservator and Buchholz relay operating mechanically on transformer oil flow rate with electrical signal for monitoring.

5.4 Suitable fire sensors to be fixed on transformer tank top cover and off circuit tap changer for sensing fire.

5.5 Signal box to be fixed on transformer side will for terminating cable connection from sensors and conservator shutter/signal box to be suitably placed.

5.6 All other consumables necessary for operation of complete system.

5.7 Control box should be microprocessor based and compatible to be interfaced with existing RTU for Railway Traction SCADA system available at the control room. For communication, Control box shall have provision for interfacing with SCADA in this regards details Digital Input & Output required for operation monitoring through SCADA should be furnished.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION:

6.1 Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.

6.2 Flanges with dummy piece in conservator pipe between Buchhloz relay and conservator tank for fixing.

6.3 Brackets on transformer top cover for sensing equipment, valves to enable operation of the system.

6.4 Spare potential free contacts for system activating signals i.e. differential relay, Buchholz relay, pressure relief valve, transformer isolation (master trip relay).

6.5 Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

6.6 Cabling on transformer top cover all sensors to be suitably connected for reliable fire sensing and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

6.7 Plinth for fire extinguishing cubicle. Oil pit with capacity as 10% of total oil quantity of transformer.

7.0 TECHNICAL DETAILS:

Fire extinction period:

On commencement of Nitrogen injection	:	Maximum 30 seconds
On system activation up to post cooling	:	Maximum 3 minutes
Heat sensing area	:	800 mm radius
Temperature for effective heat sensing		140± 2°C
Seating for operation to isolate conservator	:	Min.60 Ltr. per minute

Power Source:

Control Box	:	110 V DC
Fire extinguishing cubicle for lighting	:	240 V AC

8.0 CABLING:

8.1 Fire survival cables, able to withstand 750°C, 1.5 mm² with necessary no. of conductors for connection of fire detectors in parallel shall be used. The test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between transformer signal box/marshalling box to control box and control box tofire extinguishing cubicle shall be used.

8.3 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/marshalling box to transformer shall be used.

9.0 PREVIOUS EXPERIENCE FOR QUALIFYING SUPPLIER:

The supplier shall have a minimum experience of two years in the design, manufacturing, erection, testing and commissioning of Nitrogen Injection Fire Protection System on power transformers of similar or higher rating. At least 2 sets of the system shall be in successful operation for a minimum period of the 2 years. The supplier shall furnish the details of Nitrogen Injection Fire Protection System supplied by them so far, giving order reference, name and address of the customer, indicating the dates of commissioning as well as performance certificate of successful and satisfactory operation for minimum two years from the customers.

10.0 TESTS

10.1 Type Tests

Type test reports including that for detectors along with declared response time as per test approval certificate letter shall be submitted along with the tender.

The system shall be tested by international or a national testing body (NABL accredited recognized laboratory. Tariff Advisory Committee (TAC's) approval, if any, shall be submitted with the tender.

10.2 Factory Test

Tests will be carried out on individual equipment of the system and the total system in the supplier's workshop in presence of purchaser's representative.

10.3 Performance Test

Performance test of the complete system shall be carried out after complete erection at site by the supplier's representative. These tests shall include simulation and verification of the response of the complete system without actual draining of the oil and injection of the nitrogen gas.
In addition to above, additional tests as required necessary shall be conducted.

11.0 DRAWINGS AND MANUALS

Detailed layout drawing along with the equipment drawing to be given in the tender along with complete bill of materials. After awarding of contract, detailed dimensional drawing of the system complete bill of materials including location and size of plinth for cubicle and recommended capacity of oil soak-pit shall be submitted for purchaser's approval. After approval 10 (ten) sets of all above drawings and 5 (five) sets of operation and Maintenance Instruction Manual (bound) shall be submitted for purchaser's use.

12.0 SPARES:

One full set of spare nitrogen gas filled cylinder, one set of the installed no. of fire sensors shall be provided in addition to additional other recommended spares. The list of recommended spares is to be submitted along with the tender.

****

Annexure-2

Technical Specification for Fibre optic Winding Hot Spot Temperature Monitor

Fibre optical winding hot spot temperature monitor to be provided with transformer windings connected in parallel of the winding temperature indicator to measure transformer-winding hot spotsin real time and activate control of the cooling system.

The Fibre to be given high strength casing through rugged jacketing and fibre to be securely routed till the tank wall plate.

Specification for Fibre Optic Temperature Measurement System. Fibre optic based temperature measurement of Oil and windings shall be done using Fibre Optic sensors meeting following criteria:

1. System shall be of proven technology. The temperature sensing tip of the fibre optic shall be ruggedized. The probes shall be directly installed in each winding of power transformer to measure the winding hot spot and at the top oil temperature. There shall be at least 4 probes inside the transformer.
2. Out of the 4 probes, one probes shall be used for top oil temperature measurement and the balance 3 will be placed in the LV, HV and Tap Changer winding (One probe per winding).
3. Probes shall be able to be completely immersed in hot transformer oil they shall withstand exposure to hot vapor during the transformer insulation frying process, as part of Vacuum Phase Drying (VPD). The probes shall meet the requirement to eliminate the possibility of partial discharge in high electric stress areas in the transformer per ASTM D- 3426 and ASTM D-149 that is current (no more than 1 year old). Test results and studies to be submitted by the transformer manufacturer along with the first unit of a certain type of traction transformer.
4. Temperature range of the system should be up to +200^{0}C without any need of recalibration. Probes must connect to the tank wall plate with threaded connectors containing a Viton O-ringto prevent against oil leakage.
5. Probes shall be of material inert to mineral and ester oils, multiple jacketed (Kevlar preferred), perforated outer jacket to allow complete oil filling and mechanical strength.
6. System should include analogue outputs for each measurement channel. Temperature resolution of the analogue outputs shall be $\pm$0.1ºC and precision of +/- 0.5ºC and the system shall offer user programmable temperature alarm outputs with 8 relays (along with 1 Form C system status relay). The cooling system (Fans & Pumps) should be operated through these relays. The temperature settings for the relays shall be made as per the end user request.
7. All inputs and outputs of the system shall meet the Requirements of surge test of IEEE C37.90.1-2002 in which a 4000 V surge is applied to all the inputs and outputs without permanent damage to the instrument. The system should electronically store testing records of components and allow for on board diagnostics and instructions, including a signal strength reading to verify integrity of fibre optic connections. System should contain a battery for date/time stamp of data readings. The system should contain IEC61850 protocol, along with DNP3.0, Modbus, TCP/IP and ASCII.
8. The transformer manufacturer should submit data showing that the probes are located in the hottest point of the winding, while submitting drawings for approval.

9. The controller shall be housed in cooler cubicle or in a separate enclosure having ingress protection IP 56.

10. Temperature Rise Test Measurements shall be made with the Fibre Optic Thermometers. The equipment shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified, and temperature data for all probes recorded and reported in the test report.

******

Appendix - 9

SPECIFICATION FOR 8 MVA, 55 kV, 50Hz AUTO TRANSFORMER FOR 2 X 25 kV AT FEEDING SYSTEM

1 SCOPE

1.1 This document applies to 8 MVA, ONAN, 55/27.5 kV Autotransformer for Auto Transformer (AT) feeding system for Installation in HORC, an infrastructure providing company of Indian Railways.

1.2 The transformer shall be complete with all parts, fittings and accessories whether specifically mentioned herein or not, necessary for its efficient operation in an unattended traction substation.

2 GOVERNING SPECIFICATION

2.1 In the preparation of this document, assistance has been taken from the following National and International Standards, wherever applicable.

Table No.: 2.1-1

Standards		Description
Equivalents	**IS**	
IEC 60076 (all parts)	IS:2026 (all parts)	Power transformers.
IEC 60044-1	IS:2705	Instrument transformer – Part 1: Current transformer.
IEC 60137	IS:2099	Bushing for alternating voltages above 1000V
IEC 60214	IS:8468	Tap changers.
IEC 60296	IS:335	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear/ New insulating oils.
	IS:5	Colours for ready mix paints and Enamels.
IEC 60502-1	IS:1554 (Part1)	PVC insulated (heavy duty) Electric cables: Part 1 Forworking voltages up to and including 1100V
	IS:1570	Schedules for Wrought Steels - Part 5: Stainless and heatresisting steels.
	IS:1576	Solid pressboard for electrical purposes
IEC 60422	IS:1866	Code of practice for electrical maintenance andsupervision of mineral insulating oil in equipment
	IS:2927	Brazing alloy

JIS C 2553	IS:3024	Grain orient electrical steel sheets and strips
	IS:3637	Gas operated relays
	IS:3639	Fittings and accessories for power transformers
	IS:4253	Cork composition sheets : Part 2 Cork and Rubber
	IS:5561	Electrical power connectors
	IS:5621	Hollow insulators for use in electrical equipment
IEC 60909	IS:13234	Guide for short circuit calculations in 3Phase a.c. systems.
IEC 60270	IS: 6209	High-voltage test techniques - Partial discharge measurements.
IEC 60076	IS:6600	Guide for loading of oil-immersed transformers
	IS:10028 (all parts)	Code of practice for selection, installation andmaintenance of transformers
	IS:10593	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis
IEC 60137	IS: 12676	Oil impregnated paper insulated condensers bushings –dimensions and requirements
	DIN:7733	Laminated products, pressboard for electrical engineering,types
		Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010, part-III, Sec.4, 2010 Rule no. 44 (2) (ix).
IEC 62695		Traction Transformers
	IS: 3034	Code of practice for fire safety of industrial buildings

2.2 In case of any conflict between the contents of the above standards and this document, the latter shall prevail.

2.3 Any deviation from this document, proposed by the bidder calculated to improve the performance, utility and efficiency of the equipment, will be given due consideration; provided full particulars of the deviation with justification therefore are furnished. In such a case, the bidder shall quote according to this document and the deviations. If any proposed by him shallbe quoted as alternative/alternatives.

3 Climatic and Atmospheric Conditions

3.1 The transformer shall be suitable for outdoor use in moist tropical climate and in areas the limiting weather conditions which the equipment has to withstand in service are given in Clause 4.2, Chapter - 4 of this Specification.

3.2 The transformer would also be subjected to vibrations on account of trains running on nearby Railway tracks.

The amplitude of these vibrations which occur with rapidly varying time periods in the range of 15 to 70 ms lies in the range of 30 to 150 microns at present, with the instantaneous peaks going up to 350 microns. These vibrations may become more severe as the speeds and loads of trains increase in future.

4 TRACTION POWER SUPPLY SYSTEM (2x25 kV AT FEEDING SYSTEM)

4.1 General Scheme

4.1.1 The electric power for railway traction is supplied in ac 50 Hz, single-phase through 2x25 kV AT feeding system, which has a feeding voltage (2x25 kV) from the traction substation (TSS) two times as high as the catenary voltage, which is 25 kV with respect to earth/rail. The power fed from the TSS through catenary and feeder wire is stepped down to the catenary voltage by means of autotransformers (ATs) installed at TSS/SP/SSP/ATS and then fed to the locomotives. In other words, both the catenary and feeder voltage are, 25 kV with respect to the earth/rail, although the substation feeding voltage between catenary and feeder wires is 50 kV. The catenary voltage is therefore, the same as that in the conventional 25 kV system.

4.1.2 The power supply shall be obtained from the 220/132 kV, three-phase, effectively earthed transmission network of the Power Supply Authority of Haryana to the Scott-connected transformer installed at the TSS, whose primary winding is connected to the three phases of the transmission network. The spacing between adjacent substations is normally 60 km.

4.1.3 One outer terminal of the secondary windings of the traction transformer is connected to the catenary and the other outer terminals are connected to the feeder.

4.1.4 ATs connect the 25 kV catenary to 25 kV return feeder, with mid-point connected to rail and earth (25 kV return OHE and earth). Two adjacent AT's share power to feed trains at 25 kV/2x25 kV system feeds 50 kV supply from traction transformer terminal to the ATs. The load current (current drawn by electric locomotives) from the TSS flows through the catenary and returns to the TSS through the feeder. For a train in an AT-cell (distance between two consecutive ATs), most of the current is fed to the electric locomotive by the ATs of that AT-cell; the current returns in the rails/earth and is boosted up to the feeder through the neutral terminals of the autotransformers. The current in OHE, therefore, is an algebraic sum of 25 kV current feed to locomotives from AT and the 50 kV supply to ATs from the TSS.

4.1.5 Approximately midway between adjacent TSSs, a sectioning and paralleling post (SP) is provided. In order to prevent wrong phase coupling of power supply, a dead zone known as 'Neutral Section' is provided in the OHE opposite the TSS as well as SP. At the TSS, feeder circuit breaker for either side of the TSS for controlling the power fed to the OHE,. In case of fault in the OHE, the feeder circuit breaker of the TSS trips to isolate it. The Bridging Interrupter is used to feed one TSS up to the next TSS, in case the adjacent TSS is temporarily out of order.

4.1.6 For maintenance work and keeping the voltage drop within limit, one or more sub- sectioning and paralleling post (SSP) are provided between the TSS and SP.

4.2 Protection System

4.2.1 The Protection system of the traction transformer comprises the following:

1	Differential protection
2	Instantaneous and IDMT over-current, and earth fault protection on the primary side
3	Protection against phase-failure on the secondary side (i.e. to detect malfunction of feeder/transformer circuit breaker)
4	Buchholz Relay
5	Thermistor/Optical hot spot sensor. The Transformer should have built-in hottest spot temperature device to indicate and record the hot test spot temperature as per IEC-60076-2 (Ed. 3.0).

4.2.2 The protection system for the OHE comprises the following:

1	Distance protection
2	Delta I type fault selective protection
3	Instantaneous over current protection
4	Under-voltage protection to avoid wrong phase coupling
5	Fault locating expert system based on AT voltage neutral current.

4.3 OHE General data

4.3.1 The OHE shall consists of **(i)** Contact wire of minimum 150 mm^2 cross section suspended directly from catenary of wire of minimum 120 mm^2 cross section by a number of vertical dropper wires, usually at regular intervals and **(ii)** a feeder wire of stranded all aluminium conductor.

4.4 Auto Transformer General Data

4.4.1 The transformer shall have 8 MVA power rating based on ONAN cooling.

4.5 Nature of traction loads and faults on the OHE system

4.5.1 The traction load is a frequently and rapidly varying one, between no load and overload. The TSS equipment is subject to frequent earth faults/short circuits caused by failure of insulation, snapping of OHE touching earth, wire dropped by bird connecting the OHE to earth/ over line structure, and miscreant activity. On an average, the number of faults/ short circuits per month could be as high as 40. The magnitude of the fault current may vary between 40% and 100% of the dead short circuit value. These faults are cleared by the feeder circuit breaker on operation of the distance, delta I and instantaneous over- current relays associated with the concerned feeder circuit breaker. In 2x25 kV system faults can occur with: feeder-earth; feeder-OHE and OHE-earth faults or a combination of them.

4.5.2 The existing Indian Railways ac electric locomotives are silicon rectifiers, with dc motors or GTO/IGBT based power converter fed 3-phase Induction Motor and the average power factor generally varies between 0.7 and 0.85 lagging, without reactive power compensation, which introduces harmonic currents in the 25 kV power supply system.

4.6 Short-circuit apparent power of the system

4.6.1 The short-circuit apparent power at the transformer location for various system voltages is as under:

Highest system voltage (kV) Um	Short circuit apparent power, (MVA)
72.5	3,500
123	6,000
145	10,000
245	20,000

4.7 Auxiliary power supplies at TSS

4.7.1 The following auxiliary power supplies are available

1	110V dc from a battery
2	240 V ac, 50 Hz, single-phase from a 25/0.24 kV auxiliary transformer feed fromTraction supply.

5 RATING AND GENERAL DATA

5.1 The rating and general data of the auto transformer shall be as follows:

SN	Item	Description
1.	Type	ONAN cooled, single-phase autotransformer with centre tapping (neutral terminal), double limb wound, core-type for outdoor installation
2.	Winding	One winding with centre tapping, uniformly insulated, shall be provided. The outer (line) terminals of the winding shall be brought out through 52 kV class bushings, whereas the neutral terminal (centre tapping) through 12 kV class bushing.
3.	Rated frequency, Hz	50 $\pm$3%
4.	Rated primary voltage, kV	55
5.	Maximum primary voltage, kV	60

6.	Rated secondary voltage (at no-load), kV	27.5
7.	Rated power, MVA	8 MVA ONAN
8.	Rated current	
	1) Rated primary current, A	145.5
	2) Rated secondary current, A	290.9
9.	Maximum leakage impedance as seen from secondary side	0.45 ohm
10.	Non-cumulative overload capacity after the transformer has reached steady temperature on continuous operation at rated load (i.e.at rated power)	150% rated load for 15 min 200% rated load for 5 min
11.	Temperature rise	1. Winding: 50K at rated load, and 60K for overloadsas specified in Clause 5.1(10) (Temperature measured by resistance method). 2. Top oil: 45K (temperature rise measured bythermometer) 3. Current carrying parts in air: 40K (temperature rise measured by thermometer).
12.	Maximum permissible losses	
	1. No-load loss, kW as per IEC 60076-1 clause 3.6.1	7.5 kW
	2. Load loss, kW as per IEC60076-1 clause 3.6.3	26.5 kW
	3. Total losses, kW as per IEC 60076-1 clause 3.6.4	34 kW
13.	Short circuit current (symmetrical)	25 (Twenty five) or 35 (Thirty five) times of the ratedcurrent.
14.	Ability to withstand short circuit current of 25 (Twenty five) or 35 (Thirty five) times of the rated current	
	1. Thermal ability	5s

<table>
<tr><td></td><td>2. Dynamic ability</td><td colspan="3">0.5s</td></tr>
<tr><td>15.</td><td>Flux density at rated voltage and frequency</td><td colspan="3">Shall not exceed 1.55 Tesla.</td></tr>
<tr><td>16.</td><td>Current density in the windings at rated current</td><td colspan="3">Shall not exceed 2.5 A/mm^2</td></tr>
<tr><td>17.</td><td>Acoustic sound level when energized</td><td colspan="3">NEMA Standard TR-1 1993 (R2000) Table-2</td></tr>
<tr><td rowspan="5">18.</td><td rowspan="5">Bushing</td><td>Item</td><td>Line terminals</td><td>Neutral terminals</td></tr>
<tr><td>Type</td><td>OIP condenser</td><td>Solid or Liquid filled porcelain</td></tr>
<tr><td>Highest voltage for equipment Um(kV)</td><td>52</td><td>12</td></tr>
<tr><td>Rated current(kV)</td><td>800</td><td>800</td></tr>
<tr><td>Minimum creepag edistance in air(mm)</td><td>1300</td><td>300</td></tr>
<tr><td rowspan="10">19.</td><td>Busing type current transformer on neutral transformer for fault locator:</td><td colspan="3"></td></tr>
<tr><td>1. Highest voltage for equipment Um, kV</td><td colspan="3">12</td></tr>
<tr><td>2. CT ratio</td><td colspan="3">500/5</td></tr>
<tr><td>3. Frequency, Hz</td><td colspan="3">50 ± 3%</td></tr>
<tr><td>4. Rated output, accuracy class and accuracy limit factor as per IEC61869-1</td><td colspan="3">30VA Class
5P15</td></tr>
<tr><td>5. Minimum knee-point emf, V</td><td colspan="3">125</td></tr>
<tr><td>6. Maximum excitation current at knee-point voltage, A.</td><td colspan="3">0.25</td></tr>
<tr><td>7. Maximum resistance of the secondary winding When corrected to 75 ℃, ohm</td><td colspan="3">0.25</td></tr>
<tr><td>8. Rated short-time thermal current</td><td colspan="3">25 kA for one second</td></tr>
<tr><td>9. Rated dynamic current</td><td colspan="3">62.5 kA (peak)</td></tr>
</table>

6 SALIENT DESIGN FEATURES

6.1 Overall dimensions

6.1.1 The overall dimensions of the transformer shall be kept as low as possible and in any case shall not exceed the transportation limit.

(Transportation dimension)

1	Length x Width (in mm)	14,000 x 6,500
2	Height of topmost point of primary bushing terminal	7,500 mm
3	Height of topmost point of secondary bushing terminal	5,500mm

6.1.2 The manufacture shall, where practical, design the transformer so that with the bushings & accessories removed, the transformer shall fit within Indian Railway loading gauge, in caseit is transported through rail, MMD to be enclosed with the offer.

6.1.3 The transformer should be designed nitrogen or dry air filled, such that it can be transported without the insulation oil inside the tank. The transformer shall be designed such that it can be transported with tank under pressure with nitrogen and other protective measures that the Manufacturer recommends, so that no moisture can enters the housing.

6.2 Tank

6.2.1 The tank for the transformer shall be of the top cover jointed with bolted connection. The bottom plate of main tank shall be firmly welded to the main body and the top cover is a plate reinforced with ribs. This is subject to quality and life of windings which does not require any retightening after energized in field. A pressure gauge along with a hygrometer shall be provided so that the status of dryness of the winding can be assessed in the transformer prior to its heat run before commissioning.

6.2.2 The tank shall be constructed from mild steel of a quality that- allows welding without any defect/flaw, with a single tier construction, so shaped as to reduce welding to the minimum. The welded joints shall be made using the latest welding techniques. The tank shall be adequately strengthened for general rigidity to permit hoisting of the transformer filled with oil by crane. The tank body shall be designed to withstand full vacuum degree.

6.2.3 The tank shall be fitted with four lifting pads at the lower end to enable lifting of the transformer filled with oil by means of lifting jacks.

6.2.4 The tank shall be fitted with an under carriage and mounted on bidirectional swiveling type flanged rollers for being rolled on 1676mm (5'6") gauge track on which it shall also rest in the final position..

The rollers shall be provided with detachable type locking arrangement to enable their locking after installing the transformer in the final position, to hold the transformer fixed on foundation and to prevent any accidental movement of the transformer.

6.2.5 There shall be at least three inspection covers of suitable size on the tank to enable inspection of the lower portions of bushings, and the leads as well as the various connections inside the tank.

6.2.6 The gaskets with groove NBR (NITRILE BUTADIENE RUBBER) shall be provided for oil sealing points. The rubberized cork gasket may be used for other general portion.

6.2.7 All valves used in the transformer shall be capable to withstand full vacuum degree, conform to IS-3639. The manufacturer shall ensure that suitable anti-theft measures like locked use of blanking plates are provided on these valves, so as to prevent theft of oil during transit and service.

6.3 Marshalling box

6.3.1 A vermin proof, weatherproof and well ventilated, marshalling box with IP class 55, made up of sheet steel of thickness not less than 2 mm, strengthened with adequate stiffeners, shall be provided on the left hand side of the transformer tank as viewed from the secondary terminals side. It shall have a hinged door, with provision for padlocking the door opening outward horizontally.

6.3.2 The marshalling box shall have a sloping roof. The top of the marshalling, box shall be at a height of about 2m from the transformer rail level.

6.3.3 The marshalling box, shall house the winding and oil temperature indicators and terminal board. To prevent condensation of moisture in the marshalling box, metal clad space heater controlled by an associated thermostat and switch shall be provided. Cable glands shall be provided for the incoming and outgoing cables.

6.3.4 The temperature indicators shall be so mounted such that their dials are at a height of not more than 1.6 m from the rail level. Transparent windows of tough acrylic plastic or similar non- fragile transparent material shall be provided on the marshalling box, so as to enable reading of the temperature indicators without opening the door of the marshalling box.

6.3.5 All cables from the bushing current transformers, magnetic oil level gauge, pressure relief device and temperature indicators shall be run up to the marshalling box. The cables shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armored, stranded copper conductor conforming to IEC 60502-1. The cables shall be adequately insulated for heat from the tank surface and the sun.

6.3.6 All wiring in the marshalling box shall be clearly identified by lettered/figured ferrules of the interlock type, preferably of yellow colour with-black letters/figures. The ac and dc circuits shall be clearly distinguished and well separated from each other.

6.3.7 Suitable legend and schematic diagram plates made of anodised aluminium with black lettering and lines shall be fixed on the inside surface of the marshalling box door.

6.4 Core

6.4.1 The core shall be built-up of high permeability cold rolled grain oriented silicon steel laminations conforming to JISC 2553 or equivalent IS as indicated in Table No. 2.1-1. The flux density in any part of the core and yokes with primary winding excited at the rated primary voltage and frequency; shall not exceed 1.55T. The successful bidder / manufacturer shall furnish calculations to prove that this value shall not be exceeded.

6.4.2 The lamination for the core shall be free from waves, deformations and signs of rust. Both sides of the laminations shall be coated with suitable insulation capable of withstanding stress relief annealing. In assembling the core, air gaps shall be avoided. Necessary cooling ducts shall be provided in the core and yoke for heat dissipation The core clamping frame shall be provided with lifting eyes for the purpose of tanking and un-tanking the core and winding of the transformer.

6.4.3 The core shall be electrically solidly connected to the tank.

6.4.4 Design of the Core shall be boltless and it shall be tightened by binding the laminations using resin glass type. Core laminations shall be tested after completion of the core assembly to ensure that they withstand a voltage of 2 kV r.m.s with respect to core for a duration of 60 seconds.

6.4.5 The transformer is required to be continuously in service, preferably without requiring any attention from the date of its energization, up to the periodical overhaul (POH), which is generally done after 10-12 years of service. The successful bidder/ manufacturer of the transformer shall take this aspect into account during core assembly/manufacture and indicate measures taken by them to ensure suitable clamping to permit the above frequency and cover this in their instruction manual.

6.5 Winding

6.5.1 The winding shall be of disc/concentric/interleave/multilayer type. The winding shall be uniformly insulated. The two outer terminals of the winding shall be brought out through 52 kV OIP condenser bushings whereas the neutral terminal (Centre tapping) through a 12 kV oil-filled porcelain bushing. The QAP of the manufacturing process is to be submitted along with the bid.

6.5.2 The winding shall be made of continuous electrolytic copper conductor, paper insulated to class-A insulation. The conductor shall not have sharp edges which may damage the insulation.

6.5.3 The workmanship shall be of high quality in keeping with Good Engineering Practices.

6.5.4 No joint shall be used in the winding conductor, in principle, except for inter-leave joint.

6.5.5 The transformer winding shall be designed for the following rated withstand voltages:

1	Rated short duration power frequency withstands voltage kV	95
2	Rated lightning impulse withstand voltage kV peak	250

6.5.6 The axial pre-compression on the winding shall preferably be double the calculated axial thrust that may be set up under dead short-circuit condition, so as to ensure that the winding do not become loose due to frequent short circuits in service.

6.5.7 During short circuits the stresses set up in conductors, spacers and blocks, clamping rings and such other parts of the transformer, shall not exceed one third of the maximum permissible values.

6.5.8 Pre-compressed spacers shall be used between disc shaped coils of the winding to transmit the axial forces generated due to the short circuits.

6.5.9 Wood insulation, if used on the core and winding shall be seasoned, dried and well compressed and shall have adequate strength.

6.5.10 A uniform shrinkage shall be ensured during the drying of the individual coils or assembly of coils by providing a uniform clamping force with the help of hydraulic jacks or similar devices.

6.5.11 The separate winding compression structure shall be provided apart from the core clamping structure in order not causing any loose. The equal-axial force and continuous compression system shall be applied onto each assembled windings throughout the drying process and fixed with the high-tension, self-tightening structure to eliminate any loose, unbalanced force due to non-uniform shrinkage of windings. No re-tightening of winding after the production is prohibited.

6.5.12 The successful bidder / manufacturer shall furnish details of various stages of drying of coils, coil assembly up to and including oil impregnation and final tightening of the coil assembly, values of pressure, duration, temperature and degree of vacuum maintained at various stages of drying shall also be indicated.

6.5.13 To prevent displacement of the radial spacers used in the winding, closed slots shall be provided and a vertical locking strip shall be passed through these slots.

6.5.14 The vertical locking strips and slots of the radial spacers shall be so designed as to withstand the forces generated due to short circuits.

6.5.15 The vertical locking strips and radial spacers shall be made of pre-compressed pressboard conforming to grade PSP:3052 of DIN 7733.

6.5.16 To prevent end blocks from shifting, pre-compressed pressboard ring shall be provided in between the two adjacent blocks. Coil clamping rings made of densified wood or mild steel shall be located in position with pressure screws.

6.5.17 Leads from the winding to the terminals and other interconnections shall be properly supported and secured.

6.5.18 The following particulars / documents in respect of the radial spacer blocks (winding blocks), vertical locking strips (axial ribs), end blocks, insulating cylinder, angle rings, paper insulation of the conductor and coil clamping plates used in the manufacture of winding shall be furnished:

a) Reference to specification and grade of material.

b) Source(s) of supply.

c) Test certificates.

7 INSULATING OIL

7.1 The transformer shall be supplied with new mineral insulating oil conforming to IEC 60296. In addition, 10% extra oil by volume, shall be supplied in non-returnable steel drums. The characteristics of the insulating oil before energization of the new transformer and during its maintenance and supervision in service shall confirm to IEC 60296.

8 BUSHINGS AND TERMINAL CONNECTORS

8.1 Both the line and neutral bushings shall confirm to IEC 60137. On the line side, 52 kV class, sealed solid stem type Oil Impregnated Paper (OIP) condenser bushings shall be used. On the neutral side, 12 kV class oil-filed porcelain bushing shall be used. The dimensions of the bushings shall confirm to IEC 60137.

8.2 The OIP condenser bushings shall have a non-breathing oil expansion chamber. The expansion chamber shall be provided with an oil-level indicator, which shall be so designed and dimensioned that oil level is clearly visible from ground level. A test tap shall be provided for dielectric or power factor measurement.

8.3 The bushings shall be designed for the following insulation level:

1	Highest voltage for equipment Um, kV	52	12
2	Rated short duration wet power frequency withstand voltage, kV	95	28
3	Rated lightning impulse withstand voltage, kV peak	250	75

8.4 The design and construction of the bushing shall be such that stresses due to expansion and construction in any part of the bushings shall not lead to its deterioration / breakage. The bushings shall be free from corona and shall not cause radio interference.

8.4.1 Adjustable arcing horns shall be provided on both the line & neutral bushings. The horn gap setting shall be variable as indicated below:

1	Highest voltage for equipment Um, kV	52	12
2	Horn gap setting variable between, mm	150 & 500	60 & 100

8.5 The bushing terminals shall be provided with rigid type terminal connectors of Bimetallic type and shall be such that there is no hot spot formation even during the extreme over load condition of ONAN rating with 200% over loading.

8.6 The terminal connectors shall confirm to IS: 5561. The design shall as to be connected to the equipment terminal stud with a minimum of four 12 mm diameter bolts, nuts, spring and flat washers.

9 BUSHING TYPE CURENT TRANSFORMERS

9.1 The neutral bushing shall be so arranged as to accommodate bushing type current transformer (BCT) for connection to the AT neutral current ratio type fault locator. The BCT shall conform to IEC 61869-1 and meet with the stipulations in Clause 5.1(19) of this document.

9.2 The BCT shall be so designed as to withstand thermal and technical stresses resulting from frequent short circuits experienced by the transformer on which these are fitted.

9.3 Apart from the BCTs required for the biased differential protection, BCT of accuracy class 5 and conforming to IEC 61869-1, with suitable tappings, shall be mounted inside a line bushing for use with the winding temperature indicator.

9.4 The BCTs and the bushings shall be so mounted that removal of a bushing can be achieved without disturbing the current transformers, terminals and connections or pipe work is easy and convenient.

9.5 The leads from the BCTs shall be terminated in terminal boxes provided on the bushing turrets. Suitable links shall be provided in the terminal boxes for shorting the secondary terminals of the BCTs, when not connected to the external measuring circuits.

9.6 The leads from the secondary winding of the BCTs terminated in the terminal box on the bushing turret up to the marshalling box shall be of 1100V grade PVC insulated PVC sheathed, steel wire armoured, stranded copper cable of cross-section not less than 4 mm^2 to IEC 60502-1.

9.7 Cable glands of proper size shall be provided in the terminal boxes to lead in / lead out the cables.

10 CLEARANCES

10.1 The relative orientation in space of the bushings fitted with terminal connectors, the main tank radiators, conservator, pressure relief device, oil piping and other parts when mounted on the transformer, shall be such that the various clearances in air from live parts of bushing shall not be less than the appropriate values given hereunder:

1	Highest voltage for equipment Um, kV	52	12
2	Minimum clearance, mm	500	200

The same distance shall apply for clearance of phase-to-earth (including oil piping work, conservator, pressure relief device and such other parts), phase- to- phase and towards terminals of a lower voltage winding.

11 COOLING EQUIPMENT

11.1 The transformer shall be designed for ONAN type of cooling.

11.2 The radiators shall consist of a pressed steel plate assembly formed into elliptical oil channels or a series of separate elliptical tubes. The radiators shall be designed in such a manner that the temperature-rise limits specified under Clause 5.1(11) of this document are not exceeded.

11.3 The radiators shall be removable (after isolating the same from the main tank) to facilitate transportation of the transformer. A drain plug of size 19 mm and an air-release plug of size 19 mm shall be provided at the bottom and at the top of each radiator bank for draining and filling of oil respectively. Each radiator bank shall also be provided with shut- off valves. If radiators are supplied as a separate unit then body bellows type flexible joints shall be provided on the oil headers.

11.4 The radiators shall preferably be supported directly on the transformer tank. Each radiator bank shall be fitted with lifting lugs.

12 PARTS, FITTINGS AND ACESSORIES

12.1 Apart from the parts, fittings and accessories specifically detailed in the foregoing Clauses, the parts, fittings and accessories detailed hereunder shall be supplied with each transformer:

12.1.1 **Oil level gauge**: It shall be of magnetic type having a dial diameter of 200 to 250 mm. The gauge shall have markings corresponding to minimum oil level, maximum oillevel and oil level corresponding to oil temperature of 30^{0}C, 45^{0}C and 85^{0}C. The oil level indicator shall be so designed and mounted that the oil level is clearly visible to anoperator standing on the ground. The oil level gauge shall be fitted with two SCADA readable contacts. The first contact shall provide a warning that the oil level is at 25% above the minimum level. The second contact shall indicate when the minimum oil level has been reached.

12.1.2 **Silica Gel Breather:** Auto-transformers shall be provided with Silica Gel Breather or N2 filled without Silica Gel Breather (in case of non-breathing design).If Silica Gel breather is provided, it shall be complete with oil seal and connecting pipes. The connecting pipes shall be secured properly. The container of the silica gel breather shall be of transparent flexi glass or similar material suitable for outdoor application.

12.1.2.1 Orange silica gel (round balls 2 to 5 mm) with quantity of two DT-8 silica gel connecting with flanged mounting two pipes control through different valves as per DIN: 42567 & IS: 6401 to be provided.

12.1.3 **Pressure relief device** : It shall be designed to operate to release internal pressure at a pre-set value without endangering the equipment or operator and shall be of instantaneous reset type.

12.1.3.1 Shroud Pressure Relief Device will be used and have provision of discharge of oil from PRD to safe place by closed pipeline to avoid hazards of fire.

12.1.4 **Filter valves** : The bottom and upper filter valves shall be of 50 mm size and suitably baffled to reduce aeration of oil. The valves shall be flanged to seat 40 mm adopter threaded to thread size P 1½ for connection to oil filtration plant.

12.1.5 **Drain valve** : It shall be of size 80 mm fitted with an oil sampling device of size 15 mm.

12.1.6 **Earthing terminals**: Two earthing terminals of adequate size shall be provided on the tank for its earthing with the help of 3 mild steel flats, each of size 50 mm x 6 mm. The terminals shall be clearly marked for earthing.

12.1.7 **Oil temperature indicator (OTI)** : It shall have one alarm contact, one trip contact and two normally open spare contacts none of the contacts being earthed. The contacts shall be electrically independent.

12.1.8 **Winding temperature indicator (WTI)**: It shall have one alarm contact, one trip contact and two normally open spare contacts, none of the contacts being earthed.The contacts shall be electrically independent. The windings shall also be fitted withanalogue temperature sensors/thermistors/optical sensors that are suitable for being remote read via the SCADA system.

12.1.9 **Thermometer pockets**: A separate thermometer pocket with cap shall be provided on the tank for measuring the top oil temperature in the tank. The thermometer shall indicate hot spot temperature.

12.1.10 **Rating plate**: The rating plate shall indicate the following:

- The ratings of the transformer
- The connection diagram of the windings
- The particulars of the bushing current transformers
- Weight without oil
- Weight with oil
- Kind of transformer
- Manufacturer
- Date of manufacture
- Serial number
- Rated Voltages in (kV) and tapping range
- Rated primary and secondary currents
- Short circuit impedance
- Type of cooling

Other details as per IEC 60076-1. The rating plate shall be both in English and Hindi version.

12.2 All valves shall be of the double flange type and fitted with suitable blanking plates on the outer face of the exposed flange.

12.3 The capillary tubes for temperature indicators shall be able to withstand normal bending. They shall be supported properly without sharp or repeated bends or twists.

13 FASTENERS

13.1 All fasteners of 12 mm diameter and less exposed to atmosphere shall be of stainless steel and those above 12 mm diameter shall preferably be of stainless steel or of mildsteel hot dip galvanized to 610 g/m^2 of zinc. The material of the stainless steel fasteners shall confirm to IS: 1570 (Part-V) Grade O4Cr17Ni12Mo22 or equivalents.

14 PAINTING

14.1 Shot blasting / sand blasting shall be done on the transformer tank to remove all scales, rust and other residue, before applying the paint inside the tank. All steel surfaces which are in contact with insulating oil shall be painted with heat resistant oil — insoluble insulating varnish. All steel surfaces exposed to weather shall be given, one primer coat of zinc chromate and two coats of grey anti corrosion paint. The touch-up of gray paint shall be applied at site by the manufacturer.

15 TESTING OF TRANSFORMER

15.1 General

15.1.1 The designs and drawings together with the Quality Assurance Plan (QAP) shall be furnished to the employer, within the period stipulated in the contract.

Only after all the designs and drawings as well as the QAP have been approved for prototype tests and a written advice given to that effect shall the successful bidder / manufacturer take up manufacture of the prototype of the transformer. It is to be clearly understood that any change or modification required by the above authorities to be done in the prototype shall be done expeditiously, notwithstanding approval having already been given for the designs and drawings.

15.1.2 Prior to giving a call to the Employer for inspection and testing of the prototype, the successful bidder/ manufacturer shall submit diagrams for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. In case any dispute or disagreement arises between the successful bidder/manufacturer and representative ofthe Employer during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the Employer, as the case may be, whose decision shall be final and binding. Only after the prototype transformer is completed and ready in each and every respect, shall the successful bidder/manufacturer give the actual call for inspection and testing.

15.1.3 The type tests shall be carried out on the prototype transformer at the works of thesuccessful bidder/manufacturer or at a reputed testing laboratory in the presence of the representative of the employer in accordance with the relevant specifications and asmodified or amplified by this document.

15.2 Tests during manufacture

15.2.1 Though the test described below shall form part of the type tests, the manufacturer shall carry out these tests on first and every unit during the process of manufacture and submit the test reports to the Employer's Inspector deputed for witnessing the routine tests:

a) Oil leakage test.
b) Vacuum test.
c) Pressure test.
d) Test for pressure relief devise.
e) Measurement of capacitance and tan-delta values.

15.2.1.1 **Oil leakage test** : The transformer with its radiators, conservator tank and other parts, fittings and accessories completely assembled shall be tested for oil leakage by being filled with oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure corresponding to twice the normal static oil head or to the normal static oil head plus 35 kN/m^2 (0.35 kgf/cm^2), whichever is lower, the static oil head being measuredat the base of the tank. This pressure shall be maintained for a period of not less than 12 hours, during which time no leakage shall occur.

15.2.1.2 **Vacuum test**: The transformer tank only shall be tested at a vacuum of 3.33 kN/m^2 (0.0333 kgf/cm^2) for 60 min. The permanent deflection of flat plates after release of vacuum shall not exceed the values specified below :

Horizontal length of flat plate	Permanent deflection. mm
up to and including 750 mm	5.0
751 mm to 1250 mm	6.5
1251 mm to 1750 mm	8.0
1751 mm to 2000 mm	9.5
2001 mm to 2250 mm	11.0

2251 mm to 2500 mm	12.5
2501 mm to 3000 mm	16.0
above 3000 mm	19.0

15.2.1.1 **Pressure test** : Every transformer tank, radiator and conservator tank shall be subjected to an air pressure corresponding to twice the normal static head of oil or to the normal static oil head pressure plus 35 kN/m^2 (0.35 kgf/cm^2), whichever is lower, as measured at the base of the tank. The pressure shall remain constant for 1 hour to indicate that there is no leakage.

15.2.1.2 **Test for pressure relief devise** : Every pressure relief device shall be subjected to gradually increasing oil pressure. It shall operate before the pressure reaches the test pressure specified in Clause 15.2.1.3 hereof and the value at which ithas operated shall be recorded.

15.2.1.3 **Measurement of capacitance and tan-delta values**: The measurement of capacitance and tan-delta (dielectric loss factor) of the transformer windings shall be made by Schering Bridge.

15.3 Type Tests

15.3.1 The type tests shall be carried out on the prototype transformer at the works of the successful bidder/manufacturer or at any reputed laboratory in the presence of the representative of the Employer and in accordance with the relevant specifications and as altered, amended or supplemented by this document. Amongst others, following shall constitute the type tests:

1. Temperature-rise test.
2. Lightning impulse test.
3. Test with lightning impulse, chopped on the tail.
4. Short-circuit test.
5. Measurement of acoustic sound level.
6. Measurement of partial discharge quantity.
7. Measurement of harmonics of no-load current.

15.3.2 Temperature-rise test

15.3.2.1 The temperature-rise test shall be done in accordance IEC 60076-2 except as modified hereunder:

1	At rated load
2	At 150% rated load for 15 min after continuous operation at rated load for 1hr.
3	At 200% rated load for 5min after continuous operation at rated load for 1hr.

The tests shall be done continuously without any power supply interruption. In case interruptions of power supply to take place for some reason, then the entire rest shall be repeated after steady state condition are attained.

15.3.2.2 The points to be ensured during the temperature-rise test shall be:

1	The ambient temperature shall be measured using calibrated thermometers only
2	The winding temperature shall be determined by the resistance method only.
3	The temperature of the top oil shall be measured calibrated thermometer placed in an oil-filled thermometer pocket.
4	The average oil temperature shall be calculated as the difference between the top oil temperature and half the temperature drop in the cooling equipment (radiators)
5	The temperature of the hot-spot in the winding shall be the sum of the temperature of the top oil and 'H' times the temperature rise of the winding above the average oil temperature, where 'H' is the hot spot factor as per IEC 600076-2 and 60076-7.

15.3.2.3 The test shall be carried out as described below:

15.3.2.3.1 100% load

1	A quantum of power equal to the sum of the measured losses viz. no-load and load losses corrected to 75^{0}C plus 10% of such sum shall be fed to primary winding of the transformer with the secondary winding short-circuited.
2	The power so fed to the transformer shall be continuously maintained till such time as the steady stats temperature is reached i.e. the top oil temperature rise does not vary by more than 1^{0}C during four consecutive hourly readings
3	On attaining the steady state temperature, the current in the primary winding of the transformer shall be brought to the rated current which shall be maintained for 1 hour. At the end of the period the power supply to the transformer shall be switched off and the time of Switching off recorded.
4	The measurement of hot resistance shall commence as soon as is possible after switching off. The first reading of the resistance shall be taken as soon aspossible, before expiry of 90 seconds from the instant of switching off and the first ten readings shall be taken at intervals of l5s apart. Thereafter, another ten readings shall be taken at intervals of 30s apart.
5	The time at which each of the resistance values is read shall also be recorded.
6	The temperatures of the ambient, top oil, the top and bottom radiator header oils shall also be recorded at half-hourly intervals throughout the test starting from the instant power supply is; switched on to commence the if test till it is switched off.
7	The WTI and OTI readings shall also be recorded at half hourly intervals right from the instant the power supply is switched on to commence the test till it is switched off
8	After power supply is switched off the readings of OTI and WTI shall be recorded at intervals of 1 min apart for 30 min

15.3.2.3.2 150% load

1	After completion, of the test at 100% load, the transformer shall be fed with power which shall be a value so as to cause circulation of the rated current in the primary winding with secondary windings short circuited. This current shall be circulated for 1 hour.
2	The current shall thereafter be increased to 150% of the rated current and maintained-for a period of 15 min. At the end of the 15 min period, the power supply shall be switched off and the time of switching off recorded.
3	Thereafter, the readings as indicated in Clause 15.3.2.3.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top oil, the top & bottom radiator header oil and the temperatures indicated by OTI and WTI shall also be recorded at the time of switching on 150% load as well as at the time of switching off the power supply.

15.3.2.3.3 **200% load**

1	After completion of the test at 150% load, the transformer shall be fed with power which shall be a value so as to cause circulation of rated current in the primary with the secondary windings short circuited. This current shall be circulated for 1 hour.
2	The current shall thereafter be increased to 200% of the rated current and be maintained for 5minute period. At the end of the 5 minute period the power supply shall be switched off and the time of switching off recorded.
3	Thereafter, the readings as indicated in clause 15.3.2.3.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top-oil, top & bottom radiator header oils and temperatures indicated by OTI and WTI shall also be recorded at the time of switching on the 200% load as well as the time of switching of the power supply.

15.3.2.3.4 **Determination of thermal time constant of the winding** : The thermal time constant of the winding under both rated load and overloads shall be verified during the temperature-rise tests.

15.3.2.4 The temperature rise of the oil, winding and current carrying parts in air under both the overload conditions stipulated in Clauses 15.3.2.3.2 and 15.3.2.3.3 above shall not exceed the values stipulated in Clause 5.1(11), of this document. The winding hot-spot temperature under the overload conditions shall not exceed 115°C.

15.3.2.5 **Testing and calibration of the temperature indicators** : The functioning of the OTI and WTI shall be verified during the tests described above. Both the OTI and WTI shall be recalibrated, if necessary, to reflect the respective temperatures correctly. In particular, the reading of the WTI shall be the same as the calculated value of the hot-spot temperature of the winding.

15.3.2.6 **Determination of the thermal time constant of the WTI** : The thermal time constant of the WTI shall be determined for comparison with the thermal time constant of the winding of the transformer with respect to the transformer oil. For this purpose, the indications of the WTI and the OTI shall be recorded every 1 or 2 min during the first 1 hour from the instant the transformer is loaded. From the slope of the curve plotted with the time on the X-axis and the difference between the readings of the WTI and OTI at the particular time on the Y-axis, the thermal time constant of the WTI shall be determined.

15.3.3 Lightning impulse test

15.3.3.1 This test shall be done in accordance with IEC 60076-3. The line andneutral terminals of the winding shall be tested with the following:

1	Highest voltage for Equipment Um, kV	52	12
2	Lightning impulse withstand voltage kV peak	250	75

15.3.4 Test with lightning impulse, shopped on the tail

15.3.4.1 This test shall be done in accordance with IEC 60076-3 with the appropriate test voltage as stipulated in Clause 15.3.3.1 above

15.3.5 Short-Circuit Test

The short-circuit test shall be conducted in accordance with IEC60076-5 with the following schedule:

15.3.5.1 Prior to commencement of the test, the following measurements/ tests shall be made:

a) Insulation resistance of the winding with respect to the earth.
b) No-load current.
c) No-load loss.
d) Resistance of windings.
e) Percentage impedance voltage.
f) Load loss.
g) Voltage ratio.
h) Di-electric tests comprising :
   - Separate – source voltage withstand test, and
   - Induced overvoltage withstand test.
i) Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18.

15.3.5.2 The test will be done with secondary side short-circuited and energizing the primary sideof the transformer at its rate voltage.

15.3.5.3 The transformer shall be subjected to a total of seven shots or as per IEC 60076-5 in the following sequence:

1st Shot	Symmetrical current
2nd Shot	Asymmetrical current
3rd Shot	Asymmetrical current
4th Shot	Symmetrical current
5th Shot	Symmetrical current
6th Shot	Asymmetrical current

7th Shot	Symmetrical current

15.3.5.4 The duration of each shot shall be 0.5s

15.3.5.5 Measurement shall be done after each shot for the following:

1	Percentage impedance voltage
2	No-load current
3	No-load loss

15.3.5.6 Further testing and inspection of the transformer subjected to the short-circuit test shall be carried out as per IEC 60076-5 with the modification that:

1	The dielectric routine tests shall be at 100% of the original test value
2	The percentage impedance voltages measured after the short circuit test shall not vary by more than 2% from those measured before the short circuit test.

15.3.5.7 On completion of the short-circuit test the transformer shall be un-tanked for inspection of the core and windings. In case the inspection of the core and winding do not reveal any apparent defects and the results of the short-circuit test, the values of percentage impedance voltage as also the results of the routine tests done after the short-circuit test are in order, the transformer shall be deemed to have passed the short-circuit test.

If any of the results of the tests are not in order or the inspection of core and windings reveals any defect, then the transformer shall necessarily have to be dismantled completely for detailed inspection.

15.3.6 Measurement of acoustic sound level

15.3.6.1 Measurement of acoustic sound level of the transformer energized at rated voltage andfrequency shall be carried out as per IEC 60076-10.

15.3.7 Measurement of Partial discharge quantity

15.3.7.1 Partial discharge quantity of the windings shall be measured in accordance with IEC 60076-3.

15.3.8 Measurement of harmonics of no-load current

15.3.8.1 The magnitude of harmonics of no-load current as expressed in percentage of the fundamental shall be measured by means of a harmonic analyzer, in accordance with IEC 60076-1.

15.4 Type tests on part, fittings and accessories

15.4.1 Bushings

15.4.1.1 The type tests shall be carried out in accordance with IEC 60137 on porcelain housing ofthe bushings. The following shall constitute the type tests:

a) Visual inspection.

b) Verification of dimensions

c) Electrical routine test.

d) Porosity test.

e) Temperature cycle test.

f) Bending test.

15.4.1.2 The type tests shall be carried out in accordance with IEC 60137 on the prototype of thebushings. The following shall constitute the type test:

a) Wet power frequency withstand voltage test.
b) Dry lightning impulse voltage withstand test.
c) Thermal stability test.
d) Temperature-rise test.
e) Thermal short time current withstand test.
f) Cantilever load withstand test.
g) Tightness test.
h) Test of tap insulation.
i) Tightness test at flange or other fixing device.
j) Measurement of partial discharge quantity.

15.4.2 Bushing type current transformers

15.4.2.1 The bushing type current transformers shall be tested in accordance with IEC60044-1.

15.4.3 Terminal connectors

15.4.3.1 The terminal connectors shall be tested in accordance with IS: 5561.

15.4.4 Temperature indicators

15.4.4.1 The following tests shall be conducted in prototypes of OTI and WTI:

1	Accuracy with reference to a standard instrument
2	Calibration of the indicators to reflect the actual temperature of the oil/ windings
3	Dielectric test at 2.5kV for 60s.
4	Vibration test.
5	Dust and water splash test to IP 55 degree of protection.

15.4.5 Pressure relief device

15.4.5.1 The following tests shall be conducted on the prototype of pressure relief device:

a) Air pressure test.
b) Leakage test.
c) Contact rating and operation test.
d) Dielectric test on contacts at 2.5kV for 60 s.

15.4.6 Radiators

15.4.6.1 The radiators shall be tested for air leakage at a pressure of 2.5 kg/m^2. The pressure shall remain constant for 1 hour to indicate that there is no leakage.

15.5 Insulating oil

15.5.1 The following tests shall be carried out in accordance with IEC 60296 on the sample of new insulating oil for use in the prototype transformer:

a) Density at 27^{0}C
b) Kinematic viscosity at 27^{0}C
c) Interfacial tension at 27^{0}C
d) Flash point.
e) Neutralisation value (acidity)
f) Electric strength (with 2.5 mm gap)
g) Dielectric dissipation factor (tan-delta)
h) Specific resistance at 27^{0}C and at 90^{0}C
i) Oxidation stability
j) Water content

15.6 Routine tests

15.6.1 The following routine tests shall be performed on each transformer including the prototype unit in accordance with IEC 60076-1:

a) Visual examination
b) Insulation resistance test
c) Measurement of no-load current
d) Measurement of no-load loss
e) Measurement of resistance of the windings
f) Measurement of percentage impedance voltage
g) Measurement of load loss
h) Voltage ratio test
i) Dielectric tests comprising
   - Separate-source voltage withstand test, and
   - Induced overvoltage withstand test
j) Recording of SFRA as per IEC 60076.

15.6.2 **Visual examination**: A general examination shall be made to check that the transformer conforms to the approved drawings, various items are accessible for maintenance, the quality of workmanship and finish are of acceptable standards and all parts, fittings and accessories are provided.

15.6.3 **Insulation resistance test**: The insulation resistance of the winding with respect to the earth shall be measured using a 5 kV megger.

15.6.4 **Measurement of no-load current**: Measurement of no-load current referred to the primary side shall be done at 90%, 100%, and 110% of the rated voltage.

15.6.5 **Measurement of no-load loss**: Measurement of no-load loss shall be done at 90%, 100% and 110% of the rated voltage.

15.6.6 **Measurement of resistance of windings** : The resistance of the windings between the line and neutral terminals shall be measured and computed at 75^{0}C.

15.6.7 **Measurement of percentage impedance voltage** : The percentage impedance voltage shall be measured at rated current and at ambient temperature and computed at 75^{0}C.

15.6.8 **Measurement of load loss** : Load loss at rated current shall be measured at ambient temperature and computed at 75^{0}C.

15.6.9 **Voltage ratio test**: The voltage ratio shall be measured.

15.6.10 **Dielectric tests**

15.6.10.1 **Induced overvoltage withstand test**: The test shall be done as per IEC 60076-3.

15.6.10.2 **Separate source voltage withstand test**: A test voltage of 28 kV shall be applied between the winding and tank.

15.6.11 Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18.

15.6.12 During the routine tests of any unit, if it is found that the sum of the measured losses (i.e. no-load and load losses) corrected to 75^{0}C exceeds the value defined in Clause 15.3.2.3.1, or if the no-load loss/ load loss at the principal tapping exceeds the maximum guaranteed value defined in Clause 5.1 (12), the transformer shall be rejected.

15.7 If the prototype of a transformer conforming to this document and rating has already been approved in connection with previous supplies to Indian Railways, fresh type testing may be waived at the discretion of the Employer, provided that no changes whatsoever in the design or materials used or the process of manufacture have been made. However, the Employer reserves the right to conduct type tests if he deems it necessary to do so in the light of experience gained from previous supplies.

15.8 Only after approval of the original tracings of drawings incorporating changes, if any, as a result of the prototype tests and clear written approval of the results of. the tests on the prototype is communicated by the Employer, to the successful bidder/manufacturer, shall he take up bulk manufacture of the transformer which shall be strictly with the same materials and process of manufacture as adopted for the prototype. In no circumstances shall materials other than those approved in -the design/drawings and/or during the prototype testing be used for bulk manufacture-on the plea that they had been obtained prior to the approval of the prototype.

15.9 Transformer before dispatch should be filled with Nitrogen / dry air and provided with a gauge clearly visible for monitoring the pressure inside the tank.

16 TECHNICAL DATA AND DRAWINGS

16.1 The bidder shall furnish along with his offer in the proforma, at clause 20, the Schedule of Guaranteed Performance Technical and Other Particulars (SOGP) for the transformer. The particulars shall be complete in all respects. If there is any entry like shall be furnished later or a blank us left against any items, the offer is not likely to be considered as the evaluation of the offer is rendered difficult and cannot be compared with other offers, if any.

16.2 The bidder shall specifically indicate in a "Statement of Compliance" attached with the offer his compliance with each and every Clause of this document. In case the bidder wishes to deviate from any Clause(s) of this document, he may do so by giving reference to the Clause(s) with the reasons/justification for the deviation. This shall be in the form of a separate statement called the "Statement of Deviations".

If there is no deviation at all a specific "NIL" "Statement of Deviations" shall be attached with the offer. If the "Statement of Compliance" and "Statement of Deviations" are not attached with the offer, it is not likely to be considered for the reason that it is an incomplete offer which cannot be properly evaluated and compared with other offers, if any.

16.3 The bidder shall furnish the following information along with his offer:

16.3.1 **Calculations for**:

a) Temperature rise of winding at rated current.

b) Hot-spot temperature of the winding at 150% and 200% rated loads for 15 min and 5 min respectively.

c) Thermal withstand capacity of the windings for a short circuit of 5s duration.

d) Mechanical force in respect of the following as per IEEMA (Indian Electrical & Electronic Manufacturer's Association) formulas given in Annexure-2:

i) Hoop stress in primary and secondary windings.

ii) Compressive pressure in the radial spacers.

iii) Internal axial compressive force.

iv) Axial imbalance force.

v) Radial bursting force.

vi) Resistance to collapse.

vii) Bending stress on clamping ring and densified wood.

viii) Maximum allowable torque on pressure screws for coil clamping bolts at the time of tightening, if any

e) Flux density with the characteristic curve.

f) Maximum value of inrush current.

16.3.2 Drawings for:

a) Outline general arrangement drawing giving complete details of the transformer

b) Arrangement of the core, winding and magnetic path

c) Magnetizing characteristic of CRGO sheet steel.

17 The successful bidder/manufacturer shall submit to the employer for approval the following detailed dimensioned drawings as per Indian Railways standard in sizes of 210 mm x 297 mm or any integral multiples thereof:

a) Outline general arrangement of the transformer indicating plan, front elevation, side elevation, with all parts, fittings and accessories, electrical clearances as well as salient guaranteed particulars.

b) Internal arrangement of the transformer indicating line and neutral bushing lead connections core to core-clamp earthing, core-clamp to tank earthing, core-clamp to Core-base bolting, and the locking arrangement of the core & coil assembly with the tank.

c) Cross sectional view of the core and winding with material specifications and makes.

d) Details of the pressure screws/ oil, dash-pot/ coil clamping bolts or other devices and their location with materials specification.

e) Schematic view of the valves used on the transformer and the antitheft device so as to prevent theft of oil.

f) Transport outline dimensional diagram.

g) General arrangement of marshalling box indicating protection and control equipment.

h) Wiring diagram of marshalling box.

i) Schematic diagram of protection and control circuits in marshalling box with cable schedule.

j) Legend plate showing protection and control circuits for fitment in the marshalling box.

k) OIP condenser bushing for line terminal including cross-sectional view, shed profile and salient electrical and mechanical characteristics.

l) Oil-filled porcelain bushing for neutral terminal including cross-sectional view shed profile and salient. Electrical and mechanical characteristics.

m) Dimensional drawing, V-I characteristics and rating plate for bushing type current transformers.

n) Rigid type terminal connector for line bushing terminal.

o) Rigid type terminal connector for neutral bushing terminal.

p) Rating plate with diagram of connections both in English and Hindi versions.

q) Details of radiator

r) Details of breather.

s) External cable run with cable schedule.

t) Any other drawings considered necessary by the successful bidder/ manufacturer and / or Employer.

17.1 After approval, six copies of each of the approved drawings along with two sets of reproducible prints for each drawing shall be supplied to each consignee(s).

17.2 Two copies of the "Operations and Maintenance manual" for each transformer shall be supplied to the consignee(s) two copies of the manual shall be supplied to the employer.

18 SPARES

The bidder shall quote separately for the following essential spares for every lot of up to 5 transformers or part thereof:

a) One line bushing complete with parts, fittings and bushing type current transformer.
b) One neutral bushing complete with parts, fittings and bushing type current transformer.
c) One complete set of gaskets of all sizes required for use in the transformer.
d) One piece of radiator.
e) One terminal connector each for line and neutral side bushing terminals.
f) One set valves.
g) One pressure relief device.

19 ERRECTION TESTING AND COMMISSIONING

19.1 The transformer shall be erected and commissioned by the Contractor. The successful bidder/manufacturer shall invariably make available at site the services of an engineer to ensure, by his continued presence, that the process of erection, testing andcommissioning of the transformer is in accordance with established recommended practices. For this purpose prior intimation regarding the dates/period and locations at which the transformers are to be erected and testing/commissioning done shall be given by the Employer to the successful bidder/manufacturer. No charges shall be payable by the employer to the successful bidder/manufacturer for the services of his engineer in this regard.

20 SCHEDULE OF GUARANTEED PERFORMANCE, TECHNICAL AND OTHER PARTICULARS (GUARANTEED PARTICULARS ARE TO BE ESTABLISHED BY ACTUAL TESTS/ TEST REPORTS) (AT TSS and AT SP/SSP SEPARATELY)

SN		DESCRIPTION	UNIT OF MEASUREMENT	VALUE/ INFORMATION
1		2	3	4
A		**RATINGS/PARTICULARS**		
1.		Name of the Manufacturer		
2.		Country of manufacture		
3.		Reference to specification based on which performance data is prescribed		
4.		Rated power	MVA	
5.		Primary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
6.		Secondary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
7.		Rated voltage :		
		a) Primary	kV	
		b) Secondary (at no-load)	kV	
8.		Rated frequency	Hz	
9.		Temperature rise above ambient temperature of 50 ^{0}C :		
	(i).	Oil :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
	(ii)	Winding :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min.	^{0}C	

		c) At 200% rated load for 5 min	^{0}C	
10		Hot-spot temperature of winding over ambient temperature of 50°C	^{0}C	
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
		Interval of time between two successive overloads after continuous working at full load, at maximum ambient temperature of 50°C:		
		a) Between two consecutive over loads of 50% for 15 min	min.	
		b) Between two consecutive min overloads of which one is of 50% for 15 min and the other of 100% for 5 min.	min.	
11		No-load current referred to primary side at rated frequency and at:		
		a) 90% rated voltage	A	
		b) Rated voltage	A	
		c) 110% rated voltage	A	
12		Power factor of no-load current at rated voltage and rated frequency		
13		Value of the inrush current at rated voltage on primary side, the secondary side being opencircuited		
14		Losses:		
	(i)	No-load loss at rated frequency and at:		
		a) 90% rated voltage .	kW	
		b) rated voltage .	kW	
		c) 110% rated voltage .	kW	
			kW	
			kW	
	(ii)	Load loss (at 75 ^{0}C) at rated current and frequency	kW	
	(iii)	Total losses at rated current and frequency	kW	
15		Resistance voltage (at 75 ^{0}C) at rated current	%	
16		Reactance voltage (at 75 ^{0}C) at rated current and frequency	%	
17		Impedance voltage (at 75 ^{0}C) at rated current and frequency	%	

18		Resistance (at 75 ^{0}C) of primary winding	ohm	
19		Resistance (at 75 ^{0}C) of secondary winding	ohm	
20		Reactance of winding :	H	
	i)	Primary	H	
	ii)	Secondary	H	
21		Regulation (at 75 ^{0}C) with rated current and at power factor of:		
		a) Unity	%	
		b) 0.8 lagging	%	
22		Efficiencies:		
	(i).	Efficiency (at 75 ^{0}C) at unity power factor at:		
		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(ii).	Efficiency (at 75^{0}C) at 0.8 power factor lagging at:		
		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(iii)	Percentage of rated load at which maximum efficiency occurs.	%	
23		Ability to withstand short-circuit:		
		a). Thermal	s	
		b). Dynamic	s	
24		Thermal time constant (calculated):		
	(i)	for winding with respect to oil at:		
		a). rated current	min	
		b). 150% rated current	min	
		c). 200% rated current	min	
	(ii)	Complete transformer at rated current	min	
25		Temperature gradient between oil and winding at:		

		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min.	^{0}C	
26		Temperature rise of oil:		
	(i).	Calculated average temperature rise of oil at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min	^{0}C	
	(ii)	Estimated temperature rise of top oil at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min	^{0}C	
27		Details of core:		
	(i)	Type of core		
	(ii)	Flux density at rated voltage and frequency	tesla	
	(iii)	Flux density at 110% rated voltage and frequency	tesla	
	(iv)	Thickness of steel stampings	mm	
	(v)	Grade of core material and conforming specification		
	(vi)	Exciting VA/kg for core stampings at:		
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	VA/kg	
	(vii)	Exciting VA/kg for assembled core at:		
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	Va/kg	
	(viii)	Type of insulation between core laminations.		
	(ix)	Type of joint between the core limbs and yoke.	kV	
	(x)	Core bolt Insulation withstand voltage	kV	
	(xi)	Core bolt insulation flashover voltage	kV	

28		Details of windings:		
	(i)	Type of winding		
		(a) Primary		
		(b) Secondary		
		(c) Number of turns of primary winding		
		(d) Number of turns of secondary winding		
		(e) Number of parallel paths in primary winding		
		(f) Number of parallel paths in secondary winding.		
		(g) Is interleaving/inter shielding of the winding adopted to ensure better impulse voltage distribution?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(h) Is the insulation of end turns of winding reinforced?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(i) Type of coil		
	(ii)	Mode of connection (i.e. in series or in parallel) of the portions of the windings on the two limbs of the core, if applicable.		
	(iii)	Dimensions of the copper conductor used in the winding:		
		a) Primary	mm x mm x No. of cond.	
		b) Secondary	mm x mm x No. of cond.	
		c) Tapped winding.	mm x mm x No. of cond.	
	(iv)	Current density at rated current.		
		a) Primary	A/mm^2	
		b) Secondary	A/mm^2	
	(v)	Insulation used over the conductor (details of material and specification there for)		
	(vi)	Type of joints, if any, in the windings		
	(vii)	Dielectric strength of windings:		

		a) Full wave lightning impulse withstand voltage:		
		i) Primary winding	kV peak	
		ii) Secondary winding.	kV peak	
		(b) Lightning Impulse chopped on the tail withstand voltage:		
		(i) Primary winding	kV	
		(ii) Secondary winding	kV	
		(c) Separate source power frequency withstand voltage		
		(i) Primary	kV	
		(ii) Secondary	kV	
		(d) Induced over voltage withstand value		
	(viii)	Minimum flashover distance to earth in oil of :		
		a) Secondary winding to core	mm	
		b) Primary winding to yoke	mm	
		c) Primary winding to tank	mm	
	(ix)	Material used for coil clamping rings and specification there for		
	(x)	Magnitude of axial pre-compressive force on the winding		
		(a) Primary	kV peak	
		(b) Secondary	kV peak	
	(xi)	Calculated maximum axial thrust in the winding due to dead short circuit at the terminals		
		(a) Primary		
		(b) Secondary		
	(xii)	Calculated short circuit forces:		
		a) Hoop stress in primary winding	kgf/cm^2	
		b) Hoop stress in secondary winding	kgf/cm^2	
		c) Compressive pressure in the radial spacers	kgf/cm^2	
		d) Internal axial compressive force	kgf	
		e) Axial imbalance force	kgf	
		f) Resistance to college	kgf	

		g) Bending stress on clamping	kgf/cm^2	
		h) Radial bursting force	kgf	
	(xiii)	Arrangement to maintain constant pressure on the windings		
	(xiv)	Maximum permissible torque on pressure screws for coil clamping at the time of tightening, if any.	N.m	
	(xv)	Can either end of each secondary winding (25 kV) be connected directly to earth?	Yes/No.	
29		Bushings:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation (specify as to whether it is OIP condenser bushing)		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV	
		i) Lightning impulse withstand voltage	kV peak	
		j) Creepage distance		
		k) Weight of assembled bushing	Kg	
	(ii)	Neutral side		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV	
		i) Lightning impulse withstand voltage	kV peak	

		j) Creepage distance	mm	
		k) Weight of assembled bushing	kg	
30		Bushing type current transformers:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ratio		
		d) Accuracy class and rated accuracy limit factor		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C	ohm	
		j) Short time thermal current and duration.	kA, s	
	(ii)	Secondary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ration		
		d) Accuracy class		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C.	ohm	
		j) Short time thermal current and duration	kA, s	
31		Insulating oil :		
		a) Governing specification		
		b) Grade of oil		
		c) Source of supply		
		d) Specific resistance at:		

		i) 27 ^{0}C	ohm-cm	
		ii) 90 ^{0}C	ohm-cm	
		e) Dielectric, dissipation factor (tan-delta) at 90 ^{0}C-		
		f) Dielectric strength	kV	
		g) Water content	ppm	
		h) Interfacial tension	N/m	
		i) Neutralisation value	mg KOH/gm	
		j) Flash point	°C	
32		Type of transformer tank		
33		Details of radiators:		
		a) Make and type		
		b) Type of mounting		
		c) Overall dimensions (LxWxH)	mmx mm x mm	
34		Details of Buchholz relay:		
		a) Make and type		
		b) Governing specification		
		c) Provision of shut-off valves on either side of the relay	Yes/No	
		d) Provision of alarm contact	Yes/No	
		e) Provision of trip contact	Yes/No	
		f) Rated current of contacts	A	
35		Details of winding temperature		
		Indicator.		
		a) Make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
36		Details of oil temperature indicator		
		a) make and type		
		b) Governing specification		

		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
37		Details of Magnetic oil level gauge:		
		a) Make and type		
		b) Governing specification		
		c) Diameter of dial mm		
		d) Number of contacts provided		
		e) Rated current of contact	A	
		f) Dielectric withstand value of contacts	kV	
38		Details of pressure relief device:		
		a) Make and type		
		b) Governing specification		
		c) Does it reset itself	Yes/No	
39		Bimetallic terminal connectors:		
	(i)	Primary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45°C while carrying rated current.	°C	
		f) Short time current and duration	kA, s	
	(ii).	Secondary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45^{0}C while current rated current	°C	
		f) Short time current and duration	kA, s	

40		Acoustic sound level at a distance dB of 1 m, when energised at rated voltage and rated frequency without load.		
41		Partial discharge value at 1.5Um/ 3 kV r.m.s.	pC	
42		Weights and dimensions:		
	(i)	Net weight of core	kg	
	(ii)	Net weight of cooper:		
		a) Primary winding	kg	
		b) Secondary winding	kg	
	(iii)	Net untanking weight of core frame and coils	kg	
	(iv)	Net weight of insulating oil	kg	
	(v)	Volume of insulating oil	l	
	(vi)	Total weight of cooling equipment	t	
	(vii)	Total weight of transformer without oil	t	
	(viii)	Total shipping weight of complete transformer including all detachable parts, fittings and assemblies	t	
	(ix)	Shipping weight of largest package	t	
	(x)	Crane lift (excluding slings) for un-tanking core and coils	mm	
	(xi)	Crane lift (excluding slings) for removal of primary side bushings.	mm	
	(xii)	Dimensions of the complete transformer including all parts, fitting and accessories:		
		a) Overall length	mm	
		b) Overall breadth	mm	
		c) From rail level to the topmost point	mm	
	(xiii)	Minimum thickness of steel plate/ sheet used:		
		a) tank cover	mm	
		b) Tank bottom	mm	
		c) Conservator	mm	
		d) Radiator	mm	
		e) Marshalling box.	mm	
	(xiv)	Overall shipping dimensions of the largest package (Length x width x height)	mm x mm x mm	

	(xv)	Mode of transportation of transformer unit (filled with oil/nitrogen gas.)		
		Other particulars		
43		Is the transformer tank fitted with lifting pads? If yes, what is the number of pads	Yes/ No	
44		What is the number of inspection covers provided?		
45		Are comfits/ trays provided for cable run?	Yes/ No	
46		Is the core electrically connected with the tank?	Yes/No	
47		Will the gaskets to be used in the transformer give trouble free service for at least 7 years? If not, indicate the life.	Yes/No	
48		Is the core construction without core bolts?	Yes/No	
49		Are the core bolts grounded, and if so, how?	Yes/ No	
50		What is the number of radial spacers used in the winding?		
51		What is the number of joints provided in the winding?		
52		Are the spacers/blocks/angle rings of pre-compressed press boards? If no, indicate the material with specification.		
53		Are arrangements made for ensuring automatic constant pressure on the coils? If no. give the reasons.	Yes/ No	
54		Are closed slots provided on outer most winding for locking the vertical strips? If no, give the reason.	Yes/ No	
55		What is the periodicity for tightening of coil clamping arrangement?	Years	
56		What are the designed values of short-circuit current for:		
		a) Symmetrical :		
		i) Primary winding A		
		ii) Secondary winding A		
		b) A symmetrical:		
		i) Primary winding A		
		ii) Secondary winding A		
57		What is the over flux withstand capability of the transformer (Maximum permissible limit of flux density) ?	Tesla	
58		Are windings pre-shrunk?	Yes/No	

59		Have the details of drying cycles of thecoils/coil assembly including final tightening values of pressure, temperature and degree of vacuum at various stages of drying been furnished?	Yes/ No	
60		Are arcing horns provided for line and neutral bushings?	Yes/ No	
61		Is a test tap provided in the line bushing?	Yes/ No	
62		Is the porcelain housing of the bushings of single piece construction?	Yes/ No	
63		Is the shed profile of porcelain housing of the bushing free from under-ribs but has a lip?	Yes/ No	
64		Is the bushing type current transformer of low reactance type?	Yes/ No	
65		Is Clause by Clause "Statement of compliance" attached?	Yes/ No	
66		Is "Statement of deviation", if any, attached?	Yes/ No	
67		Deleted		
68		Deleted		
69		Are fasteners of 12 mm diameter and less exposed to atmosphere of stainless steel to Grade 04Cr17 Ni12Mo to IS 1570 Part-V?	Yes/ No	
70		Are the fasteners of more than 12 mm diameter exposed to atmosphere of stainless steel orMS hot dip galvanised?	Yes/ No	
71		Are test certificates for tests as per Clause 15.0 attached?	Yes/ No	
72		Are all the calculations required as	Yes/ No	
73		Are all the drawings required as per clause 16.3.2 attached?	Yes/ No	
74		(a) Are all the parts, fittings and accessories from Employer's approved manufacturers?	Yes/ No	
		(b) If not, list the items which are to be type tested in the presence of Employer's representative.	Yes/No	
75		Is adequate space provided in the marshalling box for housing the wiring and components?	Yes/ No	
76		Deleted		
77		Is the list of spares furnished or no?		

Enclosed:

- **Annexure - 1**, Technical Specification for Nitrogen Injection FirePrevention and Extinguishing System for Oil Filled Transformer.
- **Annexure - 2**, Formula For Calculation Of Short Circuit MechanicalForces
- **Annexure - 3**, Technical Specification for Fibre optic Winding Hot SpotTemperature Monitor
- **Annexure - 4**, List of RDSO's approved sources (vendors) - for parts,fittings & accessories for traction power transformers.

21. Specification of Auto Transformer for TSS:

Contractor shall develop specification for 12.3 MVA (minimum) Auto transformer for TSS on the lines of 8MVA Auto Transformer and shall obtain approval of Engineer.

Annexure - 1

TECHNICAL SPECIFICATIONS FOR NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM FOR OIL FILLED TRANSFORMER

1.0 GENERAL DESCRIPTION:

Nitrogen injection fire protection system designed for oil filled transformers shall prevent tank explosion and the fire during internal faults resulting in an arc, where tank explosion will normally take few seconds after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion and/or external failures like busing fires, OLTC fires and fire from surrounding equipment's.

The system shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and deduce the temperature of top oil surface below flash point to extinguish the fire.

Conservator tank oil shall be isolated during busing bursting, tank explosion and oil fire to prevent aggravation of fire.

Transformer isolation shall be an essential pre-condition for activating the system. Thesystem shall be designed to operate automatically. However, it shall be designed for manual operation, in case of failure of power supply.

The system shall consist of following equipment:

1. Fire extinguishing cubicle placed on a plinth at about 5-10 meter away from the transformer.
2. Control box placed in the control room.
3. Necessary valves in the conservator pipe.
4. Suitable fire sensing components to be provided preferably in/on the tank cover.
5. Signal box suitably placed.

2.0 SCOPE

The scope of this document covers design, engineering, supply testing at works before dispatch; erection, testing and commissioning and performance demonstration of "fire protection and extinguishing system by nitrogen injection method".

The necessary civil work which will be required for construction of oil soak — pit for the storage of oil coming out from the transformer and plinth for extinguishing cubicle is outside the scope of this document. However, laying of oil pipe, nitrogen pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary vales, fire detectors and other equipment & accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the tenderer. It will be the responsibility of the tenderer, i.e. transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests. Notwithstanding the technical specifications and requirements mentioned herewith any modification can be incorporated for correct operation of nitrogen injection fire protection system without extra cost. The full details of the same are required to be submitted to Employer for approval, when first unit is implemented on a transformer of specific make & rating.

3.0 OPERATIONAL CONTROLS:

The system shall be provided with automatic control for fire prevention and fire extinction. Besides automatic control, remote electrical push button control on control box and local manual control in the fire-extinguishing cubicle shall be provided. The fire protection system will take signal from HV/LV circuit breaker.

4.0 SYSTEM ACTIVATING SIGNALS:

4.1 Transformer isolation shall be an essential pre-condition for activating the system. Provision shall be provided to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before Nitrogen injection and after oil depressurization.

4.2 There shall be two modes of operation of Fire Protection System i.e. Fire Prevention Mode & Fire Extinction Mode. In these mode the safety equipment to be involved are tabulated below. The logic of their operation shall be finalized during design approval.

Mode of Operation	Safety Equipment to be used
Fire Prevention Mode	• Differential relay/Over current/Restricted earth fault relay. • Pressure relief valve
Fire Extinction Mode	• Fire sensing components • Buchhloz relay

5.0 SYSTEM EQUIPMENT:

5.1 Fire Extinguishing Cubicle (FEC), placed on plinth at about minimum 5 meter away from the transformer shall consist of:

5.1.1 Nitrogen gas cylinder with pressure reducer/regulator and falling pressure electrical contact manometer.

5.1.2 Oil drain pipe with mechanical quick drain valve;

5.1.3 Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.

5.1.4 Pressure monitoring switch for backup protection, pressure reducer with solenoid valve in the cabinet for operation of nitrogen gas release, which will be IP-65, protected and leak proof for nitrogen release.

5.1.5 Limit switches for monitoring of the system.

5.1.6 Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.

5.1.7 Panel lighting

5.1.8 Oil drainpipe extension of suitable sizes for connecting pipes to oil pit.

5.1.9 The Nitrogen gas cylinder should be of sufficient (not less than 50 liter) capacity and should be filled at a pressure of not less than 150 bars with falling pressure electrical contact manometer, suitable design measures to prevent leakage of gas to be taken.

5.1.10 The nitrogen valve shall have IP-65 protection. The nitrogen shall be contained within the cylinder and released from the cylinder valve only upon activation of the fire protection system. Nitrogen purity shall 99.99%

5.1.11 Proper approvals and certificates should be provided with each cylinder. No used nitrogen bottle will be accepted.

5.2 Control box with activating, monitoring devices and line faults indicators to be placed in control room. It should have audiovisual alarm indication and push button switches for tests response.

5.3 Necessary valves to be fitted in the conservator pipeline between conservator and Buchholz relay operating mechanically on transformer oil flow rate with electrical signal for monitoring.

5.4 Suitable fire sensors to be fixed on transformer tank top cover and off circuit tap changer for sensing fire.

5.5 Signal box to be fixed on transformer side will for terminating cable connection from sensors and conservator shutter/signal box to be suitably placed.

5.6 All other consumables necessary for operation of complete system.

5.7 Control box should be microprocessor based and compatible to be interfaced with existing RTU for Railway Traction SCADA system available at the control room. For communication, Control box shall have provision for interfacing with SCADA in this regards details Digital Input & Output required for operation monitoring through SCADA should be furnished.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION:

6.1 Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.

6.2 Flanges with dummy piece in conservator pipe between Buchhloz relay and conservator tank for fixing.

6.3 Brackets on transformer top cover for sensing equipment, valves to enable operation of the system.

6.4 Spare potential free contacts for system activating signals i.e. differential relay, Buchholz relay, pressure relief valve, transformer isolation (master trip relay).

6.5 Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

6.6 Cabling on transformer top cover all sensors to be suitably connected for reliable fire sensing and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

6.7 Plinth for fire extinguishing cubicle. Oil pit with capacity as 10% of total oil quantity of transformer.

7.0 TECHNICAL DETAILS:

Fire extinction period:

On commencement of Nitrogen injection	:	Maximum 30 seconds
On system activation up to post cooling	:	Maximum 3 minutes
Heat sensing area	:	800 mm radius
Temperature for effective heat sensing	:	140± 2°C
Seating for operation to isolate conservator	:	Min.60 Ltr. per minute

Power Source:

Control Box	:	110 V DC
Fire extinguishing cubicle for lighting	:	240 V AC

8.0 CABLING:

8.1 Fire survival cables, able to withstand 750°C, 1.5 mm² with necessary no. of conductors for connection of fire detectors in parallel shall be used. The test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used.

8.3 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/marshalling box to transformer shall be used.

9.0 PREVIOUS EXPERIENCE FOR QUALIFYING SUPPLIER:

The supplier shall have a minimum experience of two years in the design, manufacturing, erection, testing and commissioning of Nitrogen Injection Fire Protection System on power transformers of similar or higher rating. At least 2 sets of the system shall be in successful operation for a minimum period of the 2 years. The supplier shall furnish the details of Nitrogen Injection Fire Protection System supplied by them so far, giving order reference, name and address of the customer, indicating the dates of commissioning as well as performance certificate of successful and satisfactory operation for minimum two years from the customers.

10.0 TESTS

10.1 Type Tests

Type test reports including that for detectors along with declared response time as per test approval certificate letter shall be submitted along with the tender.

The system shall be tested by international or a national testing body (NABL accredited recognized laboratory. Tariff Advisory Committee (TAC's) approval, if any, shall be submitted with the tender.

10.2 Factory Test

Tests will be carried out on individual equipment of the system and the total system in the supplier's workshop in presence of purchaser's representative.

10.3 Performance Test

Performance test of the complete system shall be carried out after complete erection at site by the supplier's representative. These tests shall include simulation and verification of the response of the complete system without actual draining of the oil and injection of the nitrogen gas.

In addition to above, additional tests as required necessary shall be conducted.

11.0 DRAWINGS AND MANUALS

Detailed layout drawing along with the equipment drawing to be given in the tender along with complete bill of materials. After awarding of contract, detailed dimensional drawing of the system complete bill of materials including location and size of plinth for cubicle and recommended capacity of oil soak-pit shall be submitted for purchaser's approval. After approval 10 (ten) sets of all above drawings and 5 (five) sets of operation and Maintenance Instruction Manual (bound) shall be submitted for purchaser's use.

12.0 SPARES:

One full set of spare nitrogen gas filled cylinder, one set of the installed no. of fire sensors shall be provided in addition to additional other recommended spares. The list of recommended spares is to be submitted along with the tender.

****

Annexure-2

FORMULA FOR CALCULATION OF SHORT CIRCUIT MECHANICAL FORCES

Nomenclature

Ai = Total supported area of the inner radial spacer in cm^2

Ao = Total area of the outer radial spacer in cm^2

At = Area of tie road in cm^2

a = Per unit turns, out of circuit, in the winding

bi = Thickness of inside winding conductor in cm

Dmi = Mean diameter of inside winding in cm

di = Diameter of inner winding conductor in cm

§ = Current density in A/cm^2

E = Modulus of Elasticity of conductor in

kg/cm^2 ez = per unit impedance

Fa = Axial imbalance force due to tapping within winding in kgf

Fc = Internal axial compression force in kgf

Fr = Radial bursting force in

kgfhw = Winding height in cm

lph = Rated phase current in A

Isc = First peak value of asymmetrical short circuit current in A

N = Number of turns per phase in the circuit

Ns = Number of turns per phase in the circuit

Nt = Number of the tie rods

Pi = Compressive pressure in the inner radial spacer in kg/cm^2

Po = Compressive pressure in the inner radial spacer in kg/cm^2

Pt = Tensile stress in the rods in kg/cm^2

R = Sum of the resistance of the transformer and system in ohm

Rdc = dc resistance of the phase at 75^0c in ohm.

Sn = Rated kVa

X = Sum of the reactance of the transformer and system in ohm

m = Hoop or compressive in kg/cm^2

Scope

The calculation methods discussed below would be applicable to two winding transformer, having core type construction and concentric winding with tappings place within the body of the outer winding. This hence is indicative and suitable interpretation be made and calculations submitted in line with the methodology of followed in case of single-phase traction power transformer.

1. Calculation of first peak value of Asymmetrical short circuit current

Isc=k√2(Iph/e)A

k√2 values are appended below (ref. IS:2026 Part-I Clause 16.11.2)

X/R =	1	1.5	2	3	4	5	6	8	10	≥14
k√2	1.51	1.64	1.76	1.95	2.09	2.19	2.27	2.38	2.46	2.55

Note: For other values of x/R between 1 and 14, the factor k√2 may be determined by liner interpolation.

2. Calculation of Asymmetrical short circuit Ampere-turns

N x Isc

3. Hoop Stress

σm = (kxIph^{2}xRdc) / (hwxez^2)

k(Cu) = 0.03(k√2)^2/(2.55)

k√2 as derived from item 1 above.

The figure so calculated shall be less than 1250kg/cm^2

Note: The value of Iph^2 xRdc/hw referred to inner or outer winding shall be incorporated in the formula depending upon whether inner or outer winding stress is required to be calculated

4. Radial Bursting force

Fr=(2π x σm x Iph x N) / δ

5. Number of supports to be provided in winding (Flat conductor)

Ns = (Dmi x √12 xσm) / (bi x √E)

Where, E=1.13 x 10^6 kg/cm^2

6. Number of supports to be provided in winding (Round conductor)

Ns = (8 x Dmi x √1σm) / (di x √ πE)

7. Calculation of internal axial compression

Fc=(-) (34Sn)/(ez x hw)

Note: 1/3 Fc is acting on outer winding

2/3 Fc is acting on inner winding

(-) Indicated that force is acting towards the centre

8. **Calculation of Axial imbalance force due to tapping with the windings**

$Fa = a \times (Nisc)^2 x10^{-7} kg$

Note 1: If tapping are divided into two groups between the centre and the end of the windings, the force will be reduced to 1/4th of the figure obtained by the above formula.

Note 2: If the compensating gap is provided in the untapped winding, the force will be half of that calculated above.

Note 3: For multi-layer single coil design and other modes of Ampere-turn balancing actual unbalance Ampere-turns can be determined by residual Ampere-turn diagram.

9. **Calculation of Maximum compressive pressure in the radial spacers**

$Pi=(Fa+2/3Fc)Ai$ kg/cm^2

10. **Calculation of tensile stress in the tie roads**

$Pt= (Fa - 1/3Fc)/(Nt \times At)$ kg/cm^2

Fa as derived from item – 8 above

Fc as derived from item – 7 above

Note: The value calculated should be less than 2500kg/cm^2 for Mild steel tie roads.

11. **Calculation of Resistance to Collapse**

(Applicable only to disc winding using rectangular conductor)

$F (Crit) = \{1.5E(Iph)^2 \times (m) /bo /Dmo x§^2 \times 10^8\} + \{(450xAox§xb^3) / Iph\} t$

Where:

E = Modulus of Elasticity of conductor in kg/cm^2

m = Number of turns x number of Parallel Conductors per coil

Iph = Rated phase current in A

Bo = Thickness of outer winding conductor in cm

Dmo = Mean Diameter of outer winding in cm

Ƨ = Current density in A/mm^2

Ao = Total supported area of the outer radial spacer in cm^2

12. **Calculation of most highly Stressed Oil**

(Applicable for tapped winding only)

fa = (0.733 Q x Fr x $\log_{10}$ (2aNc+1) t

Where:

Q = Turns per coil adjacent to tapped out of coil, expressed as fraction of total turns in the limb

Fr = Radial force as derived from item – 4

A = Per unit number of turns out of circuit

Nc = Number of coils per limb

13. Calculation of 'W' i.e. mechanical loading per centimetre of periphery

Wl = (fa)/ πxDm) kg/cm

Where:

Fa = Value as derived from item -12 above in kg

Dm = Mean diameter of tapped winding in cm

Add 25% extra for concentration of force and assume W = 1.25 Wl

σmax = (WxL^{2}xY) / (12xlo) kg/cm^2

Where:

L = Span in cm = {(πxDm / ns) x bs}

ns = Number of Spacers

bs = Width of spacers in cm

Y = Maximum distance from neutral axis for conductor in cm i.e. axial height of the winding across the neutral axis divided by 2.

lo = Moment of inertia of the coil in cm

b = Radial depth of coil in cm

d = Axial height of coil in cm

Maximum permissible value for σmax is 1250kg/cm^2

14. Calculation of bending stress on clamping rings

The stress on circular ring is as below:

σmax = {(6π x F x D) / (8 b x t2 x n^2)} t/cm^2

Where:

F = Total axial force (Fa-1/3Fc) in t

Fa = Value as derived from item -8 above

Fc = Value as derived from item – 7 above

D = Diameter of ring in cm

b = Width of ring in cm

t = Thickness of ring in cm

n = Number of jacking points

Maximum permissible value of max is 1100kg/cm, if circular permawood ring is used.

******

Annexure-3

Technical Specification for Fibre optic Winding Hot Spot Temperature Monitor

Fibre optical winding hot spot temperature monitor to be provided with transformer windings connected in parallel of the winding temperature indicator to measure transformer-winding hot spotsin real time and activate control of the cooling system.

The Fibre to be given high strength casing through rugged jacketing and fibre to be securely routed till the tank wall plate.

Specification for Fibre Optic Temperature Measurement System. Fibre optic based temperature measurement of Oil and windings shall be done using Fibre Optic sensors meeting following criteria:

1. System shall be of proven technology. The temperature sensing tip of the fibre optic shall be ruggedized. The probes shall be directly installed in each winding of power transformer to measure the winding hot spot and at the top oil temperature. There shall be at least 4 probes inside the transformer.
2. Out of the 4 probes one probes shall be used for top oil temperature measurement and the balance 3 will be placed in the LV, HV and Tap Changer winding (One probe per winding).
3. Probes shall be able to be completely immersed in hot transformer oil they shall withstand exposure to hot vapor during the transformer insulation frying process, as part of Vacuum Phase Drying (VPD). The probes shall meet the requirement to eliminate the possibility of partial discharge in high electric stress areas in the transformer per ASTM D- 3426 and ASTM D-149 that is current (no more than 1 year old). Test results and studies to be submitted by the transformer manufacturer along with the first unit of a certain type of traction transformer.
4. Temperature range of the system should be up to +200^{0}C without any need of recalibration. Probes must connect to the tank wall plate with threaded connectors containing a Viton O-ring to prevent against oil leakage.
5. Probes shall be of material intert to mineral and ester oils, multiple jacketed (Kevlar preferred), perforated outer jacket to allow complete oil filling and mechanical strength.
6. System should include analogue outputs for each measurement channel. Temperature resolution of the analogue outputs shall be $\pm$0.1^{o}C and precision of +/- 0.5^{o}C and the system shall offer user programmable temperature alarm outputs with 8 relays (along with 1 Form C system status relay). The cooling system (Fans & Pumps) should be operated through these relays. The temperature settings for the relays shall be made as per the end user request.
7. All inputs and outputs of the system shall meet the Requirements of surge test of IEEEC37.90.1-2002 in which a 4000 V surge is applied to all the inputs and outputs without permanent damage to the instrument. The system should electronically store testing records of components and allow for on board diagnostics and instructions, including a signal strength reading to verify integrity of fibre optic connections. System should contain a battery for date/time stamp of data readings. The system should contain IEC61850 protocol, along with DNP3.0, Modbus, TCP/IP and ASCII.
8. The transformer manufacturer should submit data showing that the probes are located in the hottest point of the winding, while submitting drawings for approval.
9. The controller shall be housed in cooler cubicle or in a separate enclosure having ingress protection IP 56.
10. Temperature Rise Test Measurements shall be made with the Fibre Optic Thermometers. The

equipment shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified, and temperature data for all probes recorded and reported in the test report.

******

Annexure-4

List of RDSO's approved sources (vendors) - for parts, fittings & accessories of traction power transformers

S. No.	Description of item	Name of approved sources
1.	Buchholz relay, gas operateddouble float type, conforming toIS:3637	1. M/s Instrument & Control, Vadodara 2. M/s Atvus Industries, Calcutta
2.	Pressure relief device (Instantaneous reset type) with a trip contact.	M/s Sukrut Udyog, Pune
3.	Magnetic oil level gauge with an alarm contact (dial dia. 250 mm)	M/s Sukrut Udyog, Pune
4.	OIP condenser bushings, conforming to IS: 12676 & IS:2099.	1. M/s AREVA T&D India Ltd, Bangalore (for 245kV, 145 kV & 52 kV class). 2. M/s Crompton Greaves Ltd., Nasik (for 245 kV,145 kV & 52 kV class). 3. M/s Bharat Heavy Electricals Ltd., Bhopal (for 145 kV & 52 kV class). 4. M/s Transformers & Electricals, Kerala Ltd., Angamaly (for 145 kV & 52 kV class)
5.	Pressed steel radiators, conforming to IEEMA 9/1990	1. M/s HI- TECH Switchgears PVt. Ltd., Navi Mumbai 2. M/s CTR Manufacturing Industries, Pune 3. M/s PE Engineers PVt. Ltd., Hyderabad 4. M/s Thermal transfer products PVt. Ltd., Bangalore 5. M/s BHEL, Bhopal
6.	Mineral Inhibited Insulating oil, conforming to IS: 12463 & Railways required characteristics.	1. M/s Apar Pvt. Ltd., (Special oils refinery),Mumbai 2. M/s Raj Lubricants (Madras) Pvt. Ltd., Chennai 3. M/s Savita Oil Technologies Ltd. Mumbai 4. M/s Raj Petroleum Products Ltd Mumbai 5. M/s Tashkent Oil Company (P) Ltd., Vadodara, 6. M/s Clombia Petrochem Pvt. Ltd. Silvasa 7. M/s Panama Petrochem, Ankleshwar
7.	Bushing type current transformer, PS class, conformingto IS: 2705 (Part I &IV).	1. M/s Transformers & Electricals Kerala Ltd., Angamally 2. M/s Bharat Heavy Electricals Ltd., Jhansi 3. M/s AU Electro Machines, Allahabad 4. M/s Mahendra Electrical Works, Thane 5. M/s Narayna Powertech Pvt. Ltd. Vadodara

8.	Silica gel breather (Dehydrating).	1. M/s Atvus Industries (M/s Suvida Enterprises), Calcutta 2. M/s Yogya Enterprises, Jhansi
9.	Wheel Valve, double flanged type, conforming to IS: 3639.	1. M/s Manixon Industrial Corporation , Agra 2. M/s Girnar Industries, Agra 3. M/s AUDCO India Ltd., Marinalal Nagar 4. M/s Petson Valves, Coimbatore
10.	Motorized On Load Tap changer, conforming to IS: 8468 & IEC: 60214-2003	1. M/s Easun – MR Tap Changer Pvt. Ltd. 2. M/s CTR Manufacturing Industries, Pune
11.	Temperature Indicators — WTI & OTI, with four electrical contacts (Analog type).	1. M/s Perfect Controls, Chennai 2. M/s Premeasure, Bangalore
12.	Remote tap position indicator, winding temperature indicator, oil temperature indicator & Enunciator (digital type).	M/s Pradeep Sales & Service, Mumbai
13.	Terminals Connectors (Rigid & expansion type) conforming to IS: 5561.	1. M/s Nootan Engineering Industries, Vadodara 2. M/s Vinayak & Transmission Products (P) Ltd., Mumbai

Note: The balance items such as transformer tank, conservator, marshalling box, remote tap changer control cubicle, cooling fans etc. shall be procured from the reputed / approved sources and duly tested in accordance with this RDSO specification. Firms shall have to take RDSO, s approval before initiating procurement action in respect of above materials / items.

****

Appendix-10

JOINT DEED OF UNDERTAKING BY THE QUALIFIED EQUIPMENT MANUFACTURER ALONGWITH THE CONTRACTOR AND INDIAN EQUIPMENT MANUFACTURER/INDIAN PARTNER

THIS DEED OF UNDERTAKING executed this .... day of ....

Two Thousand and .... by

M/s. ...., a Company incorporated under the laws of .... and having its Registered Office at .... (hereinafter called the *"Qualified Equipment Manufacturer"*, which expression shall include its successors, executors and permitted assigns),

And

M/s. ...., a Company incorporated under the Indian Companies Act of 1956 and having its Registered Office at .... (hereinafter called the *"Indian Equipment Manufacturer/Indian Partner"*, which expression shall include its successors, executors and permitted assigns),

Through

M/s. ...., a Company incorporated under the laws of .... and having its Registered Office at .... (hereinafter called the *"Contractor",* which expression shall include its successors, executors and permitted assigns),

in favor of M/s Haryana Rail Infrastructure Development Corporation Limited (HRIDC), a Company incorporated under the Indian Companies Act of 1956 and having its office at Plot No. 143, 5th Floor, Railtel Tower, Sector-44, Gurugram, Haryana-122003, India (hereinafter called the *"Employer"* which expression shall include its successors, executors and permitted assigns).

WHEREAS:

1. The *"Employer"* has invited a bid as per its Tender Specification No. .... for the execution of .... *(Insert name of the SYS-1 along with project name).*

2. The *"Contractor"* at the time of bidding has submitted its bid to the *"Employer"* vide proposal No. ....dated.................for the said SYS-1 and accepted by the *"Employer",* resultinginto a contract (hereinafter called the *"Contract").*

1. The *"Contractor"* has selected "Qualified Equipment Manufacturer" along with its *"Indian Equipment Manufacturer/Indian Partner",* for the supply of Equipment, who is the qualified manufacturer of transformers in line with the Clause No.........., Section ...., of Volume... forming part of the contract.

2. Under the provisions of the contract for the supply of the Equipment, the *"Qualified Equipment Manufacturer"* will supply_________Nos. of Equipment *"Indian Partner"* will supply _________ Nos. of equipment.

NOW THEREFORE THIS UNDERTAKING WITNESSETH as under:

1.0 Without in any way affecting the generality and total responsibility in terms of this Deed of Undertaking, the Contractor, Indian Equipment Manufacturer/Indian Partner and the Qualified Equipment Manufacturer to ensure:

(i) Design of the Equipment manufactured in India shall be identical to the design of equipment to be manufactured and supplied by the Qualified Equipment Manufacturer.

(ii) Adequate up gradation of the facilities including quality systems at Indian works.

(iii) Training to staff of Indian Equipment Manufacturer/Indian Partner and certification to its trained personnel to carry out each activity.

(iv) Active involvement of Qualified Equipment Manufacturer expert in various stages of manufacturing such as for transformer winding manufacturing, core assembly, complete assembly, quality assurance and testing for the first unit of the Equipment at Indian Partner's works.

(v) MQP of Indian Equipment Manufacturer/ Indian Partner shall be same as that of Qualified Equipment Manufacturer.

(vi) Specification of raw material / major bought out components shall be same as that of Qualified Equipment Manufacturer.

(vii) Timely supply of the said equipment. In the event, the development takes time and does not meet the time schedule, Qualified Equipment Manufacturer shall supply all the equipment from their works to meet the completion schedule without any additional liability to the Employer.

(viii) If necessary the Qualified Equipment Manufacturer shall advise the Indian equipment manufacturer/Indian Partner and/or Contractor suitable modifications of designs and implement necessary corrective measures to discharge the obligations under the Contract.

(ix) The prototype tests shall be conducted for the equipment manufactured at the works of both i.e. Qualified Equipment Manufacturer as well as Indian equipment manufacturer/Indian Partner.

2.0 This Deed of Undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in Delhi shall have exclusive jurisdiction in all matters arising under the Undertaking.

3.0 We, the Qualified Equipment Manufacturer/Contractor and/or The Indian Equipment Manufacturer/Indian Partner agree that this Undertaking shall be irrevocable and shall form an integral part of the Contract and further agree that this Undertaking shall continue to be enforceable till the Employer discharges it.

IN WITNESS WHEREOF the Qualified Equipment Manufacturer, The Indian Equipment Manufacturer/Indian Partner and/or the Contractor have through their Authorized Representatives executed these presents and affixed Common seals of their respective Companies, on the day, month and year first above mentioned.

WITNESS	**(For Qualified Equipment Manufacturer)**
Signature	(Signature of the authorized representative)
Name	Name ....
Office Address	Common Seal of Company …..................
WITNESS	**(For Indian Equipment Manufacturer/ Indian Partner)**
Signature	(Signature of the authorized representative)
Name	Name ....
Office Address	Common Seal of Company …..................
WITNESS	**(For Contractor)**
Signature	(Signature of the authorized representative)
Name	Name ....
Office Address	Common Seal of Company …..................

Note:

1. The non-judicial stamp papers of appropriate value shall be purchased in the name of executants parties and the date of purchase should not be later than six months of date of execution of the Undertaking.
2. The Undertaking shall be signed on all the pages by the authorized representatives of each of the partners and should invariably be witnessed.
3. In the event the Contractor is an Indian transformer Manufacturer/Indian Partner and the Collaboration is between Qualified Transformer Manufacturer and the Contractor, then the Joint deed of undertaking shall be modified accordingly.

Appendix-11

ACCESS CONTROL SYSTEM

1. GENERAL

This section of the Specification identifies the Performance requirement of Access control system including design, supply, installation, testing and commissioning complete with all accessories for efficient and trouble-free operation.

The access control system shall be installed in the Control room Buildings of Traction substations, Switching Stations (i.e. TSS, SSP and SP etc.). The access control system shall be modular and expandable.

2. SCOPE OF WORK

Design, Supply, Installation, Testing and Commissioning of Access Control System and Security Alarm System for the following locations of Prithla – New Harsana Section of HRIDC:

(1) Main Entry gates (TSS,SP & SSP);
(2) Control Room building (TSS);
(3) Tower Wagon Shed;
(4) Electrical Room at Station;

3. FUNCTIONAL REQUIREMENTS

(1) The main Workstation PC for access control system shall be kept in the OCC and security / control room of depot and substation (TSS, SP and SSP). It should be connected with Main network PC at OCC. The access to the System shall be limited by passwords. It shall be possible to generate Time & Attendance reports from the software and Daily Report (general), Daily Report (section wise).

(2) The system shall be capable of supporting the latest technology free of risks of obsolescence such as Contactless Smart Card / Biometric finger scan/ Barcode encrypted.

(3) The System shall have facilities to have restricted control of flow of persons, monitoring and /or control of fire escape doors, recording of attendance etc. as specified in the technical specifications.

(4) The System shall have Access Control on the controlled Gates both at the Entrance and Exit. There shall be provision of prohibition of access through a gate in case the previous exit is not recorded and vice versa. This is to ensure that there is no piggyback entrance and/or exit.

(5) The System will have provision to attend the alarms from Control Room at the Main Entry gate or elsewhere.

(6) The system will have provision for automatic release of door in case of fire. The restrictive access of Access Control system will be overridden and all the controlled gates of affected rooms will be released permanently unless reset.

(7) There will be provision of overriding the controlled access in case of an emergency by manual override from the security control room.

(8) Each user shall be granted a unique a log in ID and Password.

(9) Data Communication shall be Through RS 232 / 485 connectivity to facilitate interface with other systems.

(10) The Access Control System shall have the emergency override facility to release open the locks in case of fire or any other emergency situation. Manual override is also to be provided by means of a manual glass break door release. Also a discreet key switch needs to be provided for manual override purpose.

(11) Suitable cables will be laid in separate GI conduit for Signal and Power Supply from each controller to reader. The controllers of each building will be connected through independent communication cable, which is also in the scope of work.

(12) The whole Access Control System shall be UL/FM/CE approved. The makes and nModel of the various subsystems/equipment shall be so selected that they are mutually compatible.

4. PERFORMANCE REQUIREMENTS

The performance requirement for the system shall be as below but not limited to:

4.1 Reliability

The Access system shall be designed with high reliability and single failure should not make the system non-functional.

4.2 Maintainability Requirements

All parts of the various subassemblies of the Equipment System shall be readily accessible and removable for maintenance and adjustment. The Equipment Systems shall be so designed as to ensure easy access for easy lubrication of the moving parts and at the same time meet the standard of ingress protection stipulated for that subassembly. The layout of the Equipment shall be so planned that the various subassemblies can be easily removed from their normally installed location for the purpose of cleaning, checking and readjustment of any mechanism. It shall be possible to replace critical components quickly and easily with spares held at site.

4.3 Environmental Condition Requirements

The contractor shall ensure that the entire key equipment of the system provided herein should meet environmental conditions:

Highest temperature: 50 degree C

Lowest temperature : (-) 5 degree C.

Indoor Equipment should be drip proof and outdoor should be splash proof.

(End of Chapter-19)

CHAPTER 20 – MAINTENANCE OF PSI, OHE AND SCADA WORKS

20.1 SCOPE

Contractor to carry out comprehensive maintenance of entire works under this Particular Specifications for a period of 3 (three) years from the date of taking of works by Employer. The maintenance will start from the day of start of Defect Notification Period (DNP). The maintenance requirement is completely different from DNP requirements and both should not be mixed. The work involves regular maintenance activities of PSI/OHE/SCADA systems from Prithla to Harsana Kalan section and connections to IR at Patli, Sultanpur, Asaudah and Harsana Kalan and connection from Prithla to New Prithla station of DFCCIL (145 RKM and 320 TKM). During the maintenance period Contractor to ensure that system works without any problem. All activities i.e regular, emergent and break down are covered under the scope. In case of damage to infrastructure due to accident by train, the contractor shall attend the restoration and all the cost of material shall be paid to the contractor by Employer as per cost related contract provisions but all manpower shall be arranged by contractor without any additional cost.

20.2 The items of work shall be as under:

20.2.1 Power Supply Installations

(1) Traction Substations (TSSs) (at Chandla Dungerwas and Mandothi)

(a) Incoming Bays for receiving 220/132kV double circuit power supply at TSS, the Gantry and Overhead cross feeders including terminations and insulation. Incomer bays with isolators and Circuit Breakers (CB) arrangement.

(b) Outgoing Bays shall with provision of termination of 220/132 kV, 3-phase, double circuit power supply, the Gantry and Overhead cross feeders including terminations and insulation. Outgoing bays with motorized isolators andCircuit Breaker (CB) arrangement.

(c) Metering Bays with Check meters, Metering CT, PT and the associated insulation, protection and Monitoring arrangement.

(d) 220/132 kV, AC Triple pole Circuit Breakers,

(e) 220/132 kV – Protection Current Transformers , Potential transformers,

(f) 220/132 kV, AC, Triple pole Bus Coupler circuit breaker with motorized Isolator;

(g) 220/132/55 or 2x25kV Traction Transformer(s) complete with all accessories;

(h) Circuit Breakers suitable for 2x25kV AT feeding System,

(i) Bridging interrupters suitable for 2x25kV AT feeding system;

(j) Double pole manual isolators, suitable for 2X25 KV AT feeding system;

(k) Lightning arrestors for 132 kV, 55kV and 2X25 KV AT feeding system.

(l) 55/2x25 kV & 25kV Rigid Bus bar arrangement along with required insulation and isolation.

(m) 25 kV Bus Coupler CBs. .

(n) Auto transformers.

(o) Auxiliary transformers 2 nos. 100kVA for 25kV/240V single phase supply at TSS;

(p) Single core and multi core copper Conductor, XLPE insulated cables.

(q) Return current circuit cabling (minimum 3.3kV, single core) and bonding for the tracks, Earthing and Bonding system including Buried Rail for efficient Traction return current;

(r) Control & Protection system comprising of Protection relays, Control Relay panel and CTs / PTs,

(s) Batteries and Battery Chargers;

(t) Power quality improvement equipment.

(u) Power Factor Improvement Device.

(v) Automatic Fault locator

(w) RTU and control equipment

(x) All civil works and general & yard lighting

(1) Sub Sectioning Posts (SSP) (at Sohna, Dhulawat, Manesar, Badli, Jasaur Kheri)

Sub-Sectioning Posts for 2X25 KV AT systems with following equipment:

1. Double pole circuit breakers for 2X25 AT system with Protection relays as requiredto automatically isolate fault section/ equipment.
2. Double Pole interrupters for 2X25 AT system;
3. Double pole isolators for 2X25 AT feeding system;
4. 55 kV Auto Transformers;
5. Auxiliary Transformers 10kVA, 25kV/240V, single phase;
6. Single core and multi core Conductor, XLPE insulated cables;
7. Return Current Circuit Cabling;
8. Earthing and bonding system;
9. Batteries and Chargers;
10. Lightning Arrestors;
11. Automatic Fault locator
12. RTU and control equipment
13. All Civil works and general & yard lighting.

(2) Sectioning and Paralleling Posts (SP) (at Prithla, Sultanpur, Badsa, Asaudah, New Harsana Kalan)

Sectioning and Paralleling Post for 2X25 KV AT systems with following equipment:

1. Double pole circuit breakers for 2X25 AT system with Protection relays as requiredto automatically isolate fault section/ equipment.
2. Double Pole interrupters for 2X25 AT system;
3. Double pole isolators, for 2X25 AT system;
4. 55kV Auto Transformers;
5. Auxiliary Transformers 10 kVA, 25kV/240V,single phase;
6. Single core and multi core copper Conductor, XLPE insulated cables;
7. Return Current Circuit Cabling;
8. Earthing and bonding system;
9. Batteries and Chargers;
10. Lightning Arrestors;
11. Automatic Fault locator
12. RTU and control equiptments
13. All civil works and general & yard lighting

(3) The SP at Sultanpur and Asaudah having following equipment :

1. Single Pole interrupters for 25 kV system;
2. Single Pole isolators, for 25 kV system;
3. Auxiliary Transformers 10 kVA, 25kV/240V,single phase;
4. Single core and multi core copper Conductor, XLPE insulated cables;
5. Return Current Circuit Cabling;
6. Earthing and bonding system;
7. Batteries and Chargers;
8. Lightning Arrestors;
9. RTU and control equiptments
10. All civil works and general & yard lighting

20.2.2 Overhead Equipment (OHE)

(1) Flexible polygon type (2x25kV AT Feed) OHE system

The OHE system having following equipment: :

1. 2x25kV AT Feed Overhead Equipment (OHE) on main lines; comprising Traction & Negative Feeders, Catenary & contact wires, ATD, motorized Isolators, overlaps, anchoring arrangement, cantilever, insulators, PTFE neutral section, Section Insulators etc.

2. 1x25 kV system for loop lines and yard lines;

3. 1x25 kV system for the connecting lines to Indian Railways upto IR

meeting point at Patli, Sultanpur, Asaudah and Harsana Kalan station. Prithla to New Prothla station of DFCCIL.

4. Aerial Earth Wire (AEW);
5. Buried Earth Conductor (BEC, if required);
6. Protective screen over catenary and NFW at foot over bridges (FOB) at Harsana Kalan station along with warning & danger boards with earthing.
7. Number plates, danger/caution boards, Sigma Boards etc.
8. Earthing system.

(2) Rigid Overhead Conductor System (ROCS)

1. Conductor rail.
2. Support bracket
3. Overlaps and expansion joint
4. Anchoring arrangement
5. Jumpers
6. Cantilever arm
7. Sectioning arrangement
8. Transition element
9. Earthing system
10. AEW support in tunnel
11. NFW support arrangement.

20.2.3 SCADA SYSTEM

SCADA system items are as under:

1. Remote monitoring and control of 220/132 kV TSS supply.
2. Remote monitoring and control of Traction Substations (TSS),
3. Remote monitoring and control of Sectioning Posts (SP),
4. Remote monitoring and control of Sub Sectioning Posts (SSP),
5. Remote monitoring of power supply status of Auxiliary Transformers (ATs).
6. Remote monitoring and control of switching stations (1x25 kV type) of lines joining IR at Patli, Sultanpur and Asaudah. (The RTU etc at Patli

SP shall be provided by another contractor). Being boundary posts, the control of these posts at Indian Railways Remote Control Centre is also included in this AMC work.

7. Monitoring of above TSS, Switching posts etc having switches such as Circuit Breakers, Interrupters, motorized Isolators etc,

8. The monitoring includes acquisition of data such as Voltage, Current, kVA, power factor, Maximum demand, Energy etc. with recording facilities and storage of data for a period of 3-Months time.

9. OHE Catenary Indication with auto fault localization and isolation of faulty section with monitoring fault locations as triggered by Fault Locators acting on the algorithm and logics as approved and compatible for reporting to the OCC.

10. Electrical safety and earthing of SCADA equipment which include earthing of equipment, cables and non-current carrying metallic components, etc.

11. Monitoring of check metering at TSS to register all the Energy parameters similar to those measured by Power utilities,

20.3 Maintenance Schedules and parameters

20.3.1 Maintenance schedules

Contractor shall develop daily, weekly, monthly, six-monthly, and yearly maintenance schedules and also for periodical overhaul. The Maintenance shall be undertaken as guidelines of RDSO, ACTM and Manufacturer's maintenance manuals. The various maintenance schedule i.e daily, weekly, monthly, quarterly, half yearly, yearly and periodic overhaul etc of all equipment of OHE, ROCS, TSS/SSP/SP and SCADA system along with associated works shall be submitted by Contractor for approval of Engineer. During this period, all material, tool and tackles, consumables and manpower shall be provided by Contractor.

20.3.2 Maintenance and availability parameters

Contractor shall maintain the PSI, OHE/ROCS and SCADA systems to the highest reliability index and shall not be less than:

PSI: Power availability shall be ensured 100% as 100% standby arrangement has been provided (N-1 case failure).

OHE: OHE/ROCS availability shall be 99.5%.

SCADA: Availability of SCADA hardware shall be 99.99% and SCADA Restoration time shall be less than 30 minutes.

20.4 Manpower Requirement:

The minimum requirement of manpower for maintenance shall be as under:

(1) For OHE

SN	Staff Designation	No. of persons to be deployed	Minimum Qualification	Penalty per month or part thereof per person in Rs.
1	Sr. Engineer	1	Degree in Electrical Engineering with 5 years experience of similar nature	40,000
2	Field Engineer	1 per shift	Degree in Electrical Engineering with 3 years experience of similar nature OR Diploma in Electrical Engineering with 5 years experience of similar nature	25,000
3	Skilled	5 per shift	Diplomat with 1 year experience of similar nature OR ITI with 3 years experience of similar nature	15,000
4	Semi-skilled	5 per shift	Matriculation	12,000

(2) For PSI (TSS/SP/SSP) and SCADA

SN	Staff Designation	No. of persons to be deployed	Minimum Qualification	Penalty per month or part thereof per person Rs.
1	Sr. Engineer	1	Degree in Electrical Engineering with 5 years experience of similar nature	40,000
2	Field Engineer	1 per shift	Degree in Electrical Engineering with 3 years experience of similar nature OR Diploma in Electrical Engineering with 5 years experience of similar nature	25,000
3	Skilled	5 per shift	Diplomat with 1 year experience of similar nature OR ITI with 3 years experience of similar nature	15,000
4	Semi-skilled	5 per shift	Matriculation	12,000
5	Field Engineer (SCADA)	1 per shift	Degree in Electrical or Electronics or Communications Engineering with 3 years experience of similar nature OR Diploma in Electrical or Electronics or Communications Engineering with 5 years experience of similar nature	25,000

(3) The above are the minimum manpower which shall be provided all the time and manpower shall be augmented by Contractor as per actual work requirement. Necessary manpower as leave reserve etc shall be kept and manpower as

mentioned per shift shall be ensured.

(4) There shall be maintenance offices at Sohna, Manesar & Khakhoda and Contractor shall depute staff at all these locations suitably in consultation with the Employer. Contractor may depute staff at other locations also as per requirement.

20.5 Office and OHE/PSI depot:

20.5.1 Contractor shall set-up OHE/PSI Depot, corresponding stores, repair shops, which includes furniture, computers, material racks staff cup-boards, tools & Tackles, instruments, material handling instruments, communication instruments, material consumable etc. For proper upkeep of all the installations at least 2 vehicles shall be kept in OHE/PSI depot. In addition at least one vehicle shall be kept at other maintenance locations.

20.5.2 The space for office and OHE/PSI depot (approximately 1000 sqm) shall be provided by Employer, free of cost. Water and Electricity shall be supplied by the Employer free of cost but emergency arrangement shall be made by Contractor, if Employer's water and electricity are not available due to any reason.

20.5.3 Contractor shall train and supervise staff under his control and ensure that staff operate and maintain the equipment properly and in particular do actually observe all prescribed rules and regulations, Joint Procedure orders shall be issued for safety precautions, SHE policy to ensure proper safety. Personnel Protective Equipment (PPE) shall invariably be used while working on the system and no staff shall be allowed to work without PPE.

20.5.4 Contractor shall ensure that special testing instruments, tool and equipment including the OHE inspection cars (provided and maintained by others) for maintenance of OHE are properly cared for and maintained in in proper condition. The break down vehicles provided by Contractor shall always be in working condition.

20.5.5 Contractor shall provide and maintain an emergency road vehicle (with driver) in good working condition all the time and keep all spares and T&P in ready to use condition. In case Emergency road Vehicle is under maintenance, standby arrangements are to be made by Contractor. Emergency Road vehicle shall be of sufficient capacity so that it can carry all T&P and spares including 7 metre Long Aluminum Ladders and with sufficient seating capacity for maintenance gang.

20.6 Material during AMC period

(1) All the materials, consumables, lubricants, tools & tackles, measuring instruments, transport road vehicle etc or any thing else required during maintenance i.e routine, emergent and break down shall be arranged by the Contractor. All the spares (list given in Chapter 13.2) shall be issued one time by the Employer to contractor for maintenance and restoration of OHE/PSI as per site requirement on recoupment basis. Any Spare item, if consumed by contractor for maintenance/restoration purpose of HORC, shall be recouped with brand new item by contractor within a period of 3 months from date of consumption. The contractor shall keep all the Spares of

OHE/PSI in respective Depots at all the times with maximum allowed delay of 3 months which will be in case of recoupment due to unforeseen events. A penalty of amount of two times of the latest market rate of Spare item shall be imposed by Employer on contractor in case of Non compliance of recoupment within 3 months. The contractor shall handover all the Spares (as per list given in Chapter 13.2) to Employer 6 weeks prior to completion of Maintenance period (with or without extension) in unused condition duly recouped with brand-new Spare items.

(2) During damage to any infrastructure due accident to a train, the restoration shall be attended by Contractor and all the material cost shall be paid to the contractor by Employer as per cost provisions available in the contract. Any material available with the Employer shall be given to the contractor. All the manpower shall be arranged by the contractor without any cost.

(3) Tower wagon of Employer shall be used by contractor shall be maintained by Contractor and all the maintenance cost shall be borne by the contractor. All the fuels and lubricants shall be arranged by the contractor. Competent and trained Tower wagon driver shall be employed by contractor at own cost.

20.7 Permit to work

Contractor shall train all the staff regarding permit-to -work system and issue competency certificate to staff with the consent of Employer. The Competent staff shall only undertake OHE/PSI work only after obtaining permission from TPC (Traction Power Controller) to undertake the work.

20.8 Periodical reports to Employer:

Contractor shall submit the periodical returns after careful scrutiny to Employer as under:

i) Work done during the day
ii) Failure analysis reports
iii) Unusual occurrence reports
iv) Power block and PTW reports
v) Accidental reports
vi) Staff position reports

Further reports as desired by Employer shall be submitted by Contractor.

20.9 Contractor shall keep sufficient tools & tackles and testing & measuring instruments at all times for maintenance of PSI, PHE, ROCS and SCADA system. The indicative list is as under:

List of Special Tools and Instrument

S. No	Description	Quantity in No's
1.	Cable Fault Locator	1 sets
2.	AC Power Line Analyzer	2 nos.
3.	Digital earth testers	3 nos.
4.	Earth Leakage Detector 1000 V	3 nos.
5.	Digital Insulation Tester 2.5/ 5 kV	3 nos.

6.	Digital Insulation Tester 0 – 1000 V	3 nos.
7.	Dynamo Meter (5.0 T x 20 Kg)	1 nos.
8.	Vernier Caliper	1 nos.
9.	Walky Talkie Set	6 nos.
10.	Primary injection test kit	1 nos.
11.	Secondary injection test kit	1 nos.
12.	Relay Testing Kits	1 nos.
13.	Infra-red remote temperature sensor	2 nos.
14.	Fully automatic Oil dielectric test kit with printer	1 nos.
15.	i) Thermal Imaging Camera capable of being mounted on Tower Wagon /loco ii) Hand held Thermal Imaging camera	2 nos. 2 nos.
16.	Height and Stagger gauge (instrument laser based)	4 sets
17.	Dissolved Gas Analyzer set	1 nos.
18.	Hydraulic Compressor for Aluminum conductor Splicing Zig (all sizes)	1 sets
19.	Turfers all weight categories	10 each type
20.	Pull lift all weight category	10 each type
21.	Come-along clamps for different conductors	20 for each size
22.	Discharge Rod complete including earthing cable and connectors	20 nos.
23.	Aluminum Ladders (5 m and 11 m extendable)	15 each
24.	Portable petrol/ kerosene set 1.5 KVA	5 nos.
25.	Vehicle mounted Oil filtration plant 1 phase 3000 liters per hour capacity	1 nos.
26.	Portable diesel Generating set 3 kVA 230 V.A.C.	2 nos.
27.	150 sq.mm Contact wire Cutter 36"	10 nos.
28.	Wire Cutter 12"	10 nos.
29.	"D" Shackle set (1",3/4", 5/8", &1" One Each)	20 nos.
30.	Single sleeve Pulley Block 3.5" x 5/8" Groove Fiber for drawl of contact. &catenary wire	20 nos.
31.	Portable rail drill machine.	5 nos.
32.	Siren 3 phase Range 5 Km and 1 phase Range 1 Km	2 each
33.	Ladder Trolley capable of running on track	2 nos.
34.	DE and Ring Spanner sets suitable for Fittings being supplied	20 nos.
35.	Chain pulley block all weight category as	10 nos.

	required for erection	
36.	Hydraulic insulator testing jig	2 nos.
37.	Copper Hammer	5 nos.
38.	Nonmetallic Hammer	2 nos.
39.	Micro Meter	5 nos.
40.	Fiber measuring Tape 30 mtr. & 15 mtr. Each	10 nos.
41.	Isolator pad lock	10 nos.
42.	Neutral Section inspection Jig	2 nos.
43.	Nylon rope 20 meters length	10 nos.
44.	Diagnostic kit (LAPTOP) along with softwarecapable of testing all type of modules to identify Faults	3 nos.
45.	Digital Multi-meter	3 nos
46.	Portable operated tree pruner	5 nos
47.	Motorised Earth Augur	2 nos
48.	Crimping Tools for droppers/ conductors (all types)	10 nos
49.	Operating rod for DO fuse (Pull Rod)	5 nos
50.	Inflatable lighting tower	3 nos
51.	Portable Power hacksaw	3 nos
52.	Safety Helmet	50 nos
53.	Safety Harness	10 nos
54.	Hand blower	2 nos
55.	Vehicle mounted Oil filtration plant 1 phase 300 liters per hour capacity	2 nos
56.	Box spanner set	3 nos
57.	Portable Tan Delta & Capacitance Measuring Bridge	2 nos
58.	Capacitance meter	2 nos
59.	Portable grinder Electrically operated	2 nos
60.	Steel sling with eye each end 1 m, 2 m and 3 m	10 each
61.	Steel sling with eye each end 5 m, 10 m	5 each
62.	Twister cum bender 6"	10 nos
63.	33 kV gloves	2 sets
64.	Oliver – G	1 no
65.	Truck for major maintenance and attending breakdown	1 no
66.	Road Vehicles for regular maintenance	3 nos (minimum)

The above list is indicative and Contractor shall arrange additional tools & tackles and testing & measuring instruments as per the requirement.

20.10 AMC Contract and penalty:

(1) Contractor shall sign an agreement with the Employer at least 6 months prior to start of the Defect Notification Period. All terms and conditions including various maintenance schedules shall be incorporated in the agreement.

(2) On receipt of information of any failure of OHE, PSI, SCADA, the Contractor's staff shall reach the site within 30 (thirty) minutes and attend the failure within 90 (ninety

minutes) of receipt of information. If failure is not attended within ninety minutes, a penalty of Rs 10,000/- (Rs ten thousand only) per hour (beyond ninety minutes) shall be levied when train operation is not affected and Rs 50,000/- (Rs fifty thousand only) when train operation is affected. The annual cumulative penalty shall be limited to 10% (ten percent) of the annual AMC price.

(End of Chapter- 20)

PART 2 – Employer's Requirements

Section VII-3: Tender Drawings

PART-2: EMPLOYER'S REQUIREMENTS
SECTION-VII-3: TENDER DRAWINGS

LIST OF DRAWINGS

A. Electrical Drawings

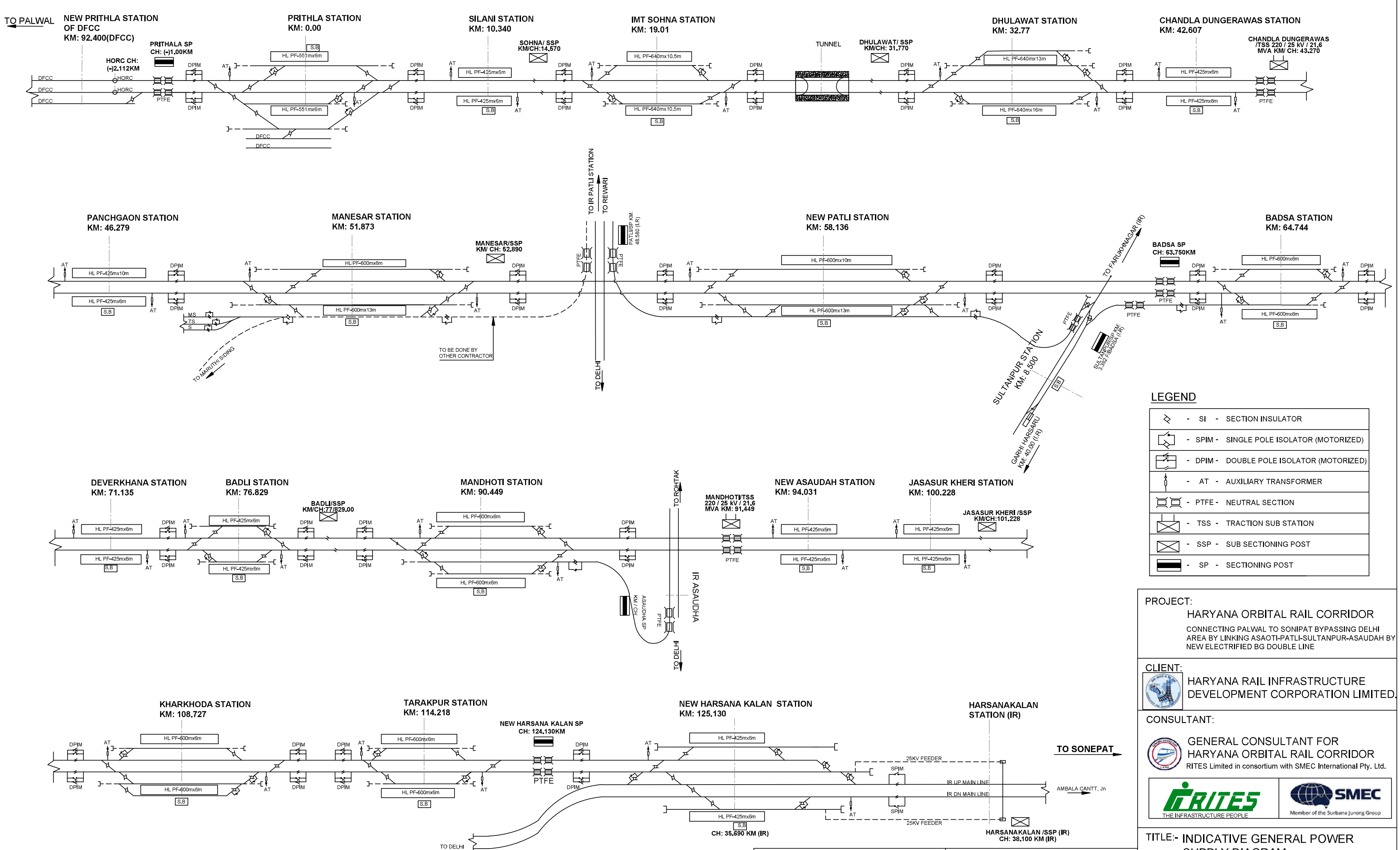
S.No	Description	Drawing No.
1	Indicative General Power Supply Diagram	GC-HRIDC-SYS1-DRW-ELE-001-A0
2	Indicative OHE System for Open Route on Tangent Track	GC-HRIDC-SYS1-DRW-ELE-002-A0
3	Indicative OHE System for Open Route on Curved Track	GC-HRIDC-SYS1-DRW-ELE-003-A0
4	Indicative Typical Arrangement of Portal and Earthing of OHE Structure and Rails	GC-HRIDC-SYS1-DRW-ELE-004-A0
5	Indicative Typical Arrangement of BEC with OHE Structure and Rails	GC-HRIDC-SYS1-DRW-ELE-005-A0
6	Indicative OHE, Earthing & Bonding Arrangement on RCC Bridge/ Viaduct	GC-HRIDC-SYS1-DRW-ELE-006-A0
7	Indicative OHE Guy Rod Arrangement on Steel Bridge/ Viaduct	GC-HRIDC-SYS1-DRW-ELE-007-A0
8	Indicative Typical Sectioning Arrangement of Station	GC-HRIDC-SYS1-DRW-ELE-008-A0
9	Indicative OHE Mast on Girder Bridge with Earthing	GC-HRIDC-SYS1-DRW-ELE-009-A0
10	Indicative Earthing & Bonding of OHE Structure along the Bridge, Girders (RCC) & Piers	GC-HRIDC-SYS1-DRW-ELE-010-A0
11	Indicative 2x25 kV High Rise ROCS in Tunnel	GC-HRIDC-SYS1-DRW-ELE-011-A0
12	Indicative Single Line Diagram of Traction Substation 220/132/2x25kV Scott Connected Transformer	GC-HRIDC-SYS1-DRW-ELE-012-A0
13	Indicative Control Room at TSS	GC-HRIDC-SYS1-DRW-ELE-013-A0
14	Indicative Single Line Diagram of Sectioning Post(SP)	GC-HRIDC-SYS1-DRW-ELE-014-A0
15	Indicative Single Line Diagram of Sub-Sectioning Post(SSP)	GC-HRIDC-SYS1-DRW-ELE-015-A0
16	Indicative Plan and Elevation for SP& SSP	GC-HRIDC-SYS1-DRW-ELE-016-A0
17	Indicative Drawing for TSS/SP/ SSP Fencing	GC-HRIDC-SYS1-DRW-ELE-017-A0
18	Indicative General Arrangement Block Diagram for Traction SCADA Control	GC-HRIDC-SYS1-DRW-ELE-018-A0
19	Indicative General Arrangement Block Diagram for Auxiliary SCADA Control	GC-HRIDC-SYS1-DRW-ELE-019-A0
20	Indicative Plan and Elevation for Tower Wagon Shed	GC-HRIDC-SYS1-DRW-ELE-020-A0
21	Indicative Cable Route Plan for Motorised Isolator	GC-HRIDC-SYS1-DRW-ELE-021-A0

B. Civil Drawings

S.No	Description	Drawing No.
1	Plan and L-Section from – 2.12 km to -0.6 km	GC-HRIDC-ALL-DRW-ALN-P&P-(-2.12)-(-0.6) KM-A0
2	Plan and L-Section from - 0.6 km to 0 km	GC-HRIDC-ALL-DRW-ALN-P&P-(-0.6)-0 KM-A0
3	Plan and L-Section from 0 km to 5 km	GC-HRIDC-ALL-DRW-ALN-P&P-0-5 KM-A0
4	Plan and L-Section from 5 km to 10 km	GC-HRIDC-ALL-DRW-ALN-P&P-5-10 KM-A0
5	Plan and L-Section from 10 km to 15 km (Tunnel)	GC-HRIDC-ALL-DRW-ALN-P&P-10-15 KM-A2
6	Plan and L-Section from 15 km to 20 km	GC-HRIDC-ALL-DRW-ALN-P&P-15-20 KM-A2
7	Plan and L-Section from 20 km to 25 km	GC-HRIDC-ALL-DRW-ALN-P&P-20-25 KM-A0
8	Plan and L-Section from 24 km to 30 km (Tunnel)	GC-HRIDC-ALL-DRW-ALN-P&P-24-30 KM-A0
9	Plan and L-Section from 29 km to 33 km	GC-HRIDC-ALL-DRW-ALN-P&P-29-33 KM-A1
10	Plan and L-Section from 33 km to 35 km	GC-HRIDC-ALL-DRW-ALN-P&P-33-35 KM-A1
11	Plan and L-Section from 35 km to 40 km	GC-HRIDC-ALL-DRW-ALN-P&P-35-40 KM-A1
12	Plan and L-Section from 40 km to 45 km	GC-HRIDC-ALL-DRW-ALN-P&P-40-45 KM-A1
13	Plan and L-Section from 45 km to 50 km	GC-HRIDC-ALL-DRW-ALN-P&P-45-50 KM-A1
14	Plan and L-Section from 49.7 km to 55.6 km (Main Line)	49.7 KM TO 55.6 KM
15	Plan and L-Section from 55 km to 61.5 km	GC-HRIDC-ALL-DRW-ALN-P&P-55-61.5 KM-A1
16	Plan and L-Section from 60 km to 65 km	60 KM TO 65 KM
17	Plan and L-Section from 65 km to 70 km	65 KM TO 70 KM
18	Plan and L-Section from 70 km to 75 km	70 KM TO 75 KM
19	Plan and L-Section from 75 km to 80 km	75 KM TO 80 KM
20	Plan and L-Section from 80 km to 85 km	80 KM TO 85 KM
21	Plan and L-Section from 85 km to 90 km	85 KM TO 90 KM
22	Plan and L-Section from 90 km to 95 km	90 KM TO 95 KM
23	Plan and L-Section from 95 km to 100 km	95 KM TO 100 KM
24	Plan and L-Section from 100 km to 105 km	100 KM TO 105 KM
25	Plan and L-Section from 105 km to 110 km	105 KM TO 110 KM

S.No	Description	Drawing No.
26	Plan and L-Section from 110 km to 115 km	110 KM TO 115 KM
27	Plan and L-Section from 115 km to 120 km	115 KM TO 120 KM
28	Plan and L-Section from 120 km to 125 km	120 KM TO 125 KM
29	Plan and L-Section from 125 km to 126 km	125 KM TO 126 KM
30	Plan and L-Section from Chainage 0 km to 5.72 km (Connectivity Line)	MANESAR TO PATLI CONNECTIVITY
31	Plan and L-Section Connectivity Towards Patli	GC-HRIDC-C2-DRW-ALN-P&P-03001-A2
32	Plan and L-Section Connectivity Towards Sultanpur	GC-HRIDC-C2-DRW-ALN-P&P-04001-A2
33	Connectivity Towards Sultanpur from Badsa	GC-HRIDC-C2-DRW-ALN-P&P-05001-A0
34	Plan and L-Section Mandothi to Asaudah Connectivity	MANDOTHI TO ASAUDAH CONNECTIVITY
35	Re-Grading of Garhi Harsaru-Farukhnagar Main Line of Sultanpur Station Yard (Conceptual)	GC-HRIDC-C2-DRW-ALN-P&P-06001-A1
36	Conceptual Plan Typical Embankment/ Cutting Profile	GC-HRIDC-SK-GEN-001-A2

A. Electrical Drawings



PROJECT: HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT: HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT: GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

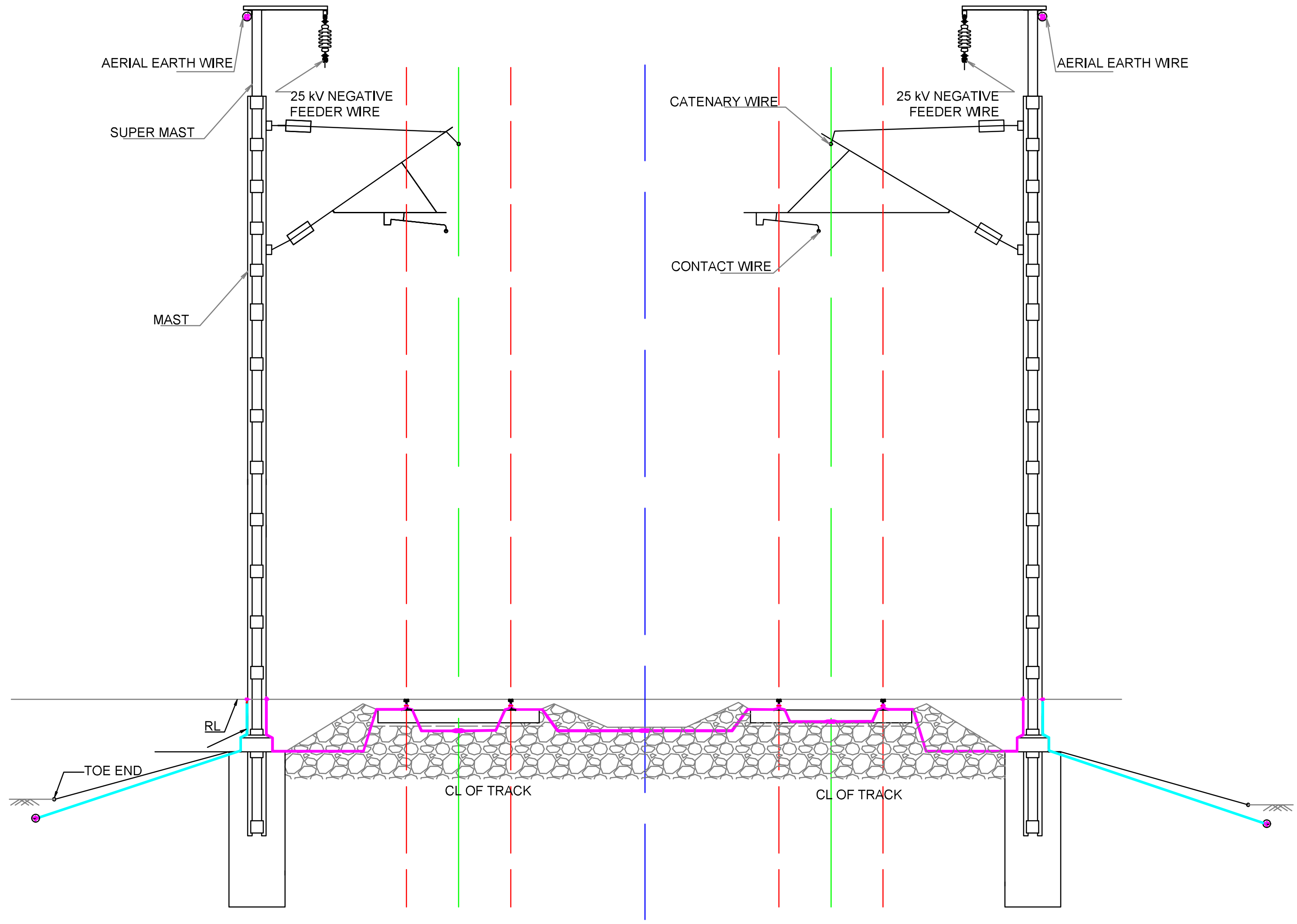
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE GENERAL POWER SUPPLY DIAGRAM

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-001_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		



LEGEND

RAILS	
TRACK CENTRE	
TRACK TO TRACK CENTRE	
50x6 mm MS FLAT	
20mm DIA G.S. STRANDED WIRE	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

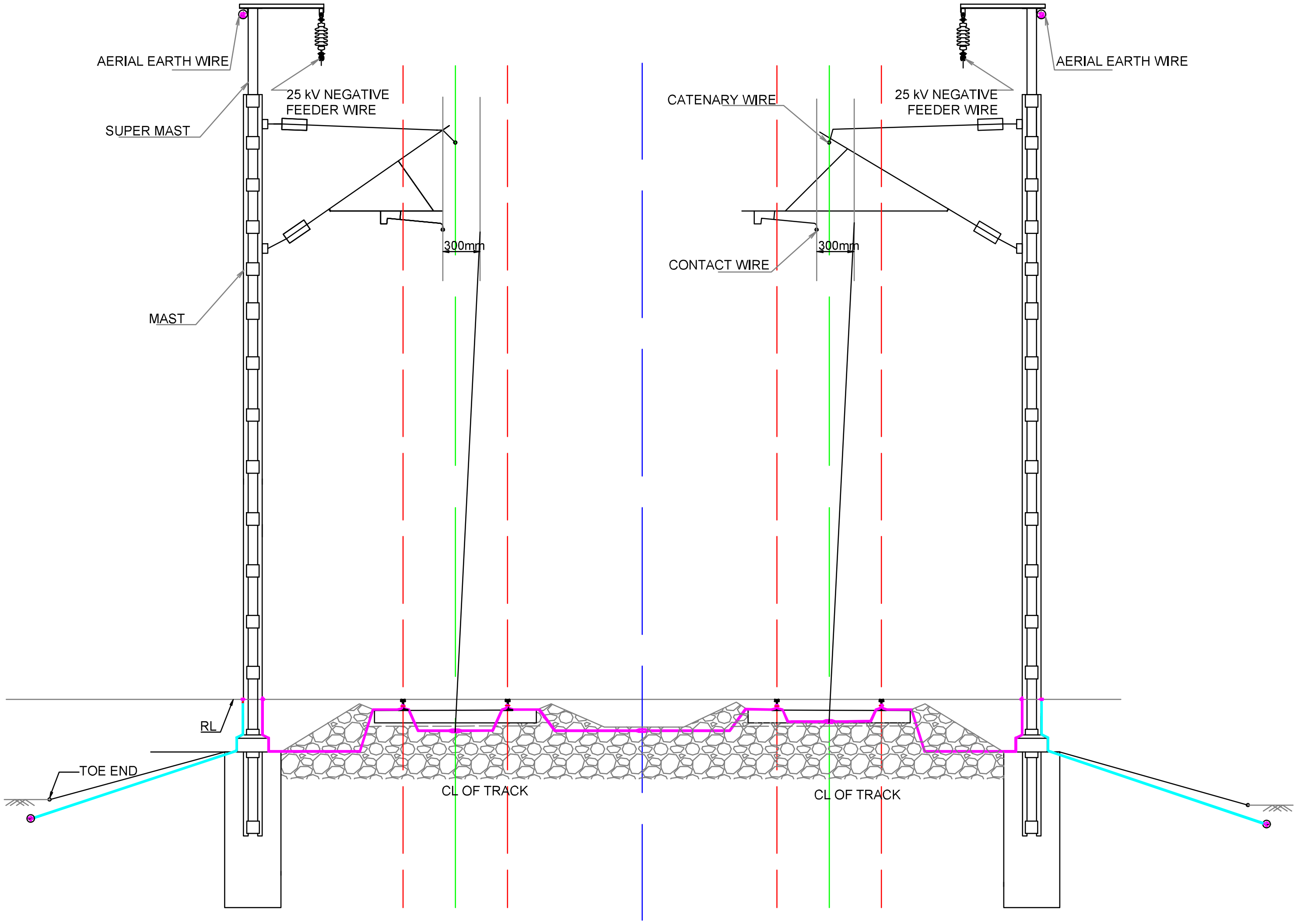
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE OHE SYSTEM FOR OPEN ROUTE ON TANGENT TRACK

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	ChahateyRam	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-002_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	



LEGEND

RAILS	
TRACK CENTRE	
TRACK TO TRACK CENTRE	
50x6 mm MS FLAT	
20mm DIA G.S. STRANDED WIRE	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

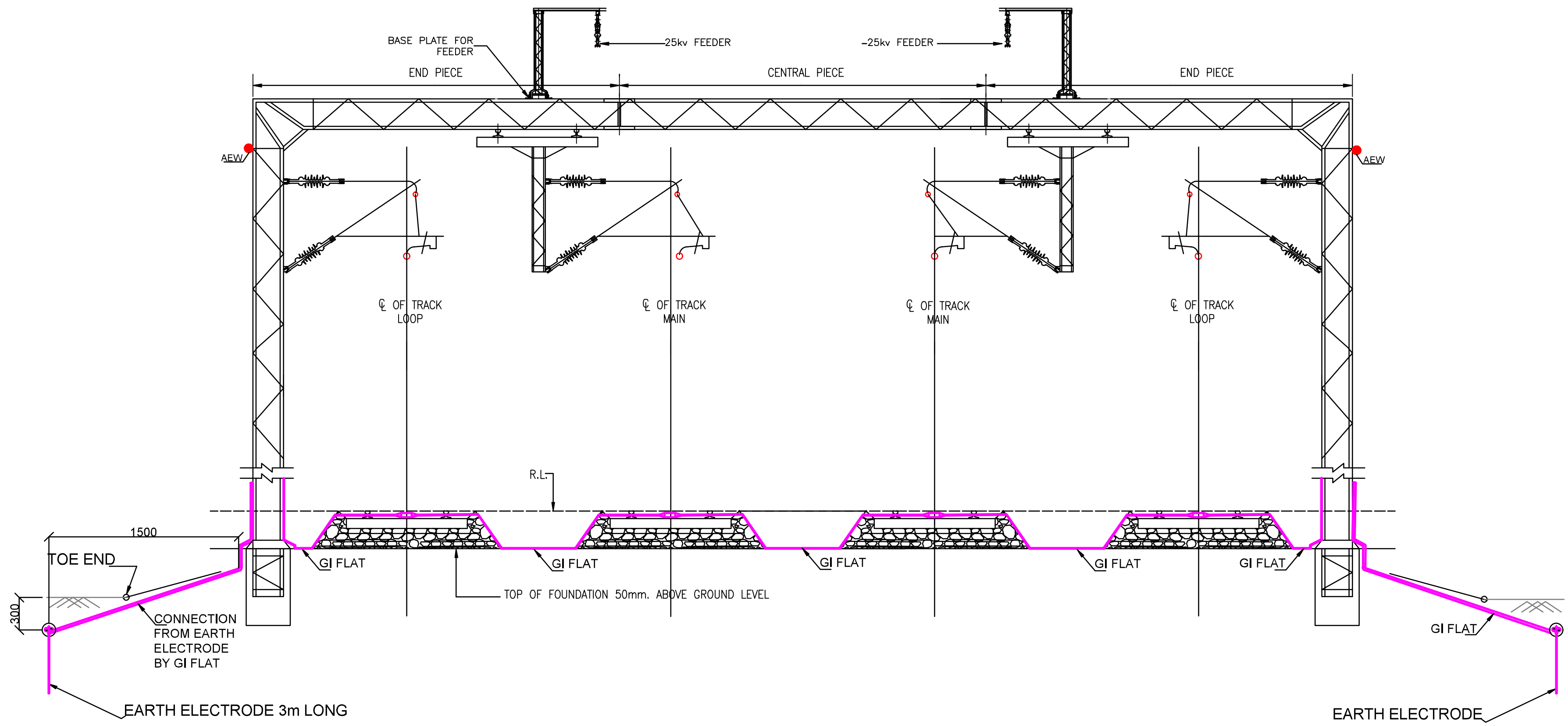
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	ChahateyRam	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

TITLE:- INDICATIVE OHE SYSTEM FOR OPEN ROUTE ON CURVED TRACK

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-003_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	



NOTE:

1. THE INTERCONNECTION OF EARTH ELECTRODE, MAST/ PORTAL, RUNNING RAILS, MAST/ PORTAL, EARTH ELECTRODE, SHALL BE MADE AT REGULAR INTERVALS BASED ON RESULTS OF SIMULATION STUDY BUT INTERCONNECTION INTERVAL SHALL NOT EXCEED 400m.

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

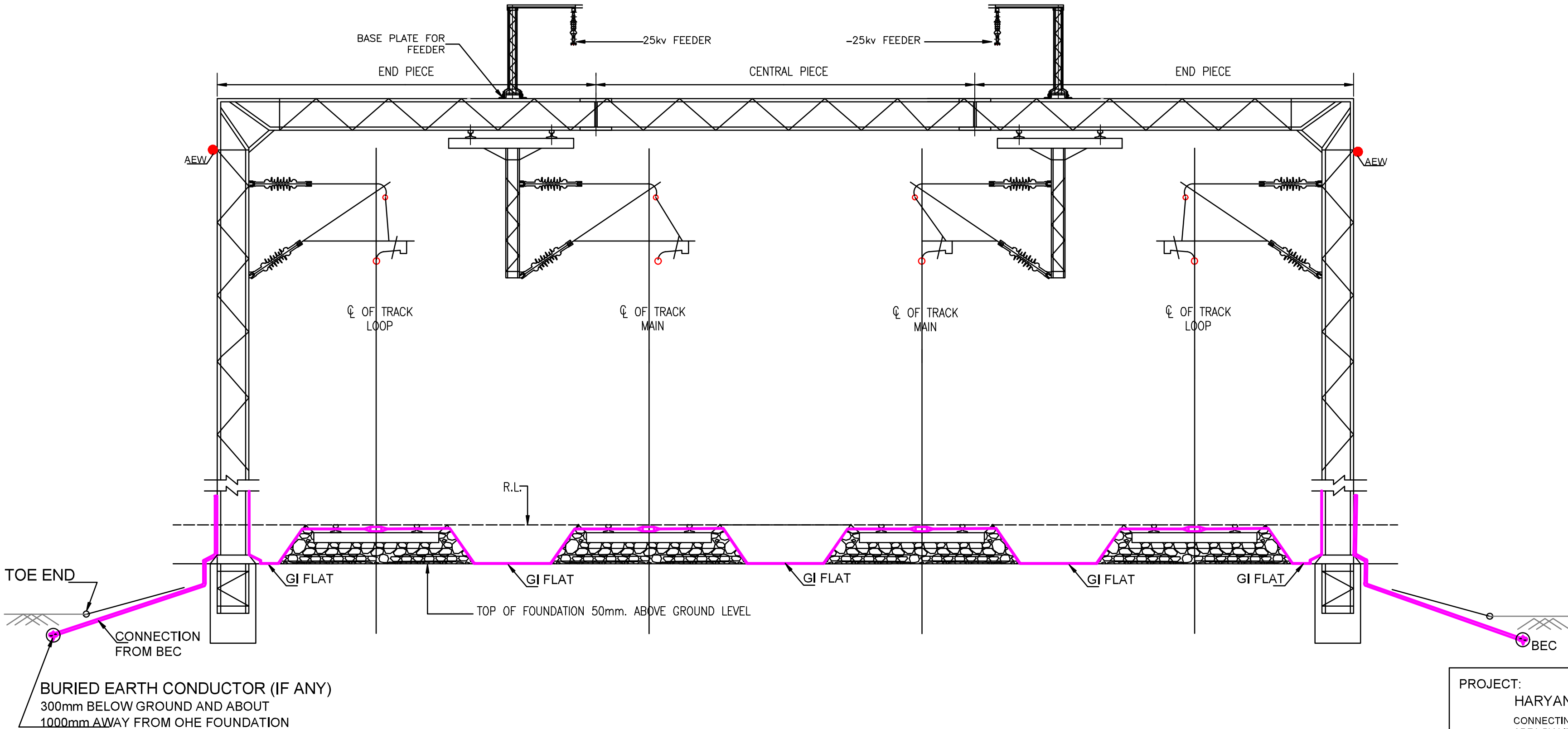
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE TYPICAL ARRANGEMENT OF PORTAL AND EARTHING OF OHE STRUCTURE AND RAILS

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-004_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	



NOTE:

1. BURIED EARTH CONDUCTOR SHALL BE PROVIDED BASED ON RESULTS OF SIMULATION STUDY.
2. THE INTERCONNECTION OF BEC, MAST/ PORTAL, RUNNING RAILS, MAST/ PORTAL, BEC SHALL BE MADE AT REGULAR INTERVALS BASED ON RESULTS OF SIMULATION STUDY.

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	[signature]	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

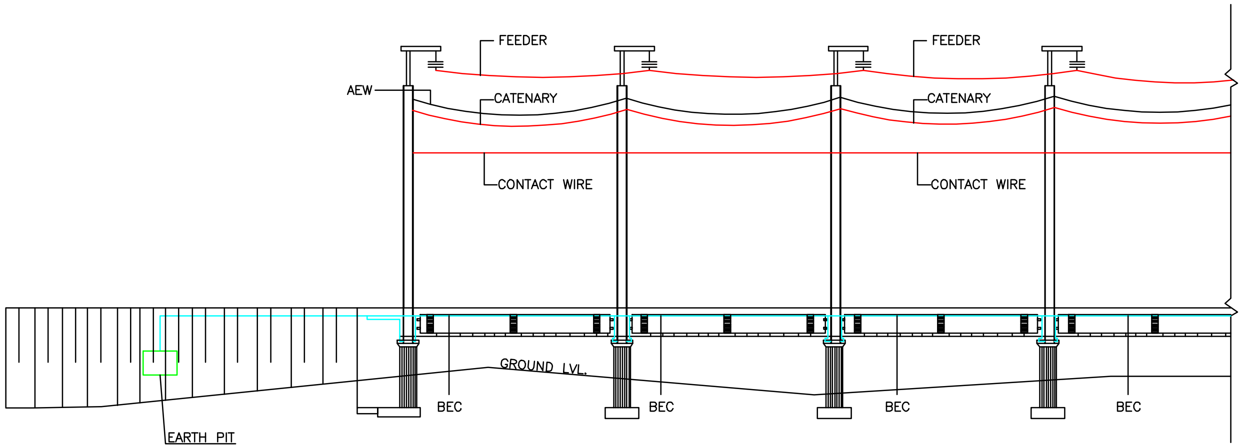
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

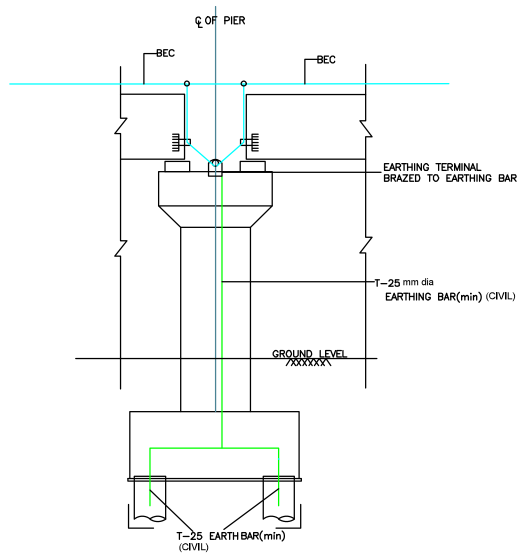
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE TYPICAL ARRANGEMENT OF BEC WITH OHE STRUCTURE AND RAILS

DRG. NO.			SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-005_A0			
SCALE :	ISSUE DATE	REVISED DATE	
AS SHOWN	31.03.2023		





EARTHING BAR IN THE PIER

Colour Code

- Earthing(CIVIL)
- OHE(LIVE)
- Conductor

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

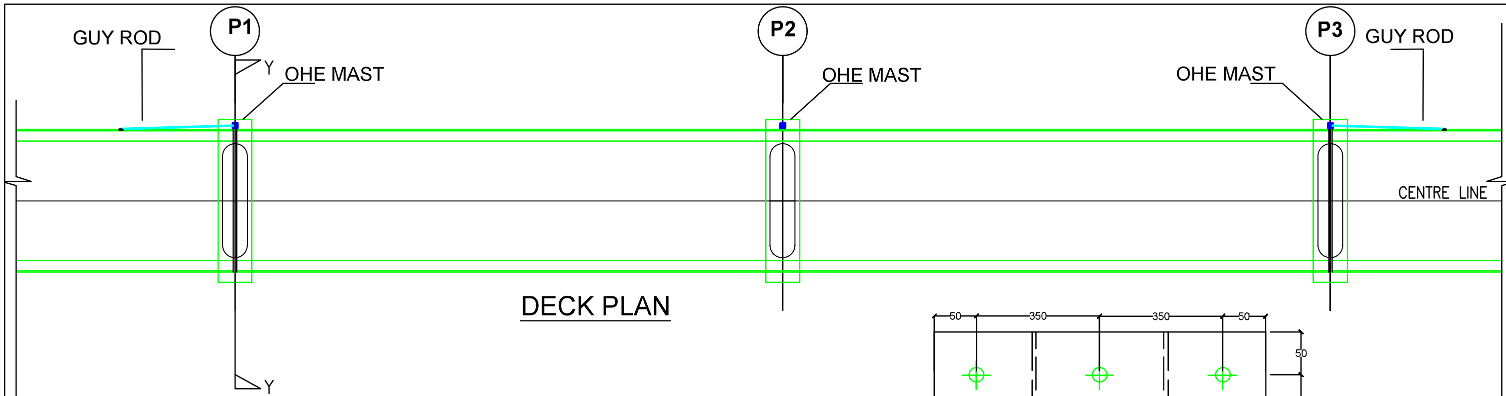
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

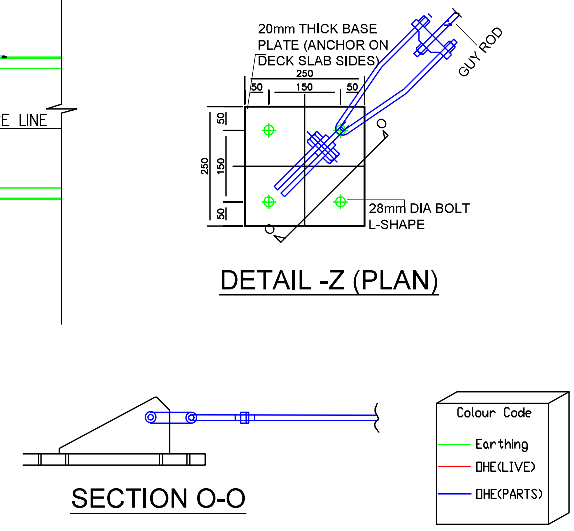
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

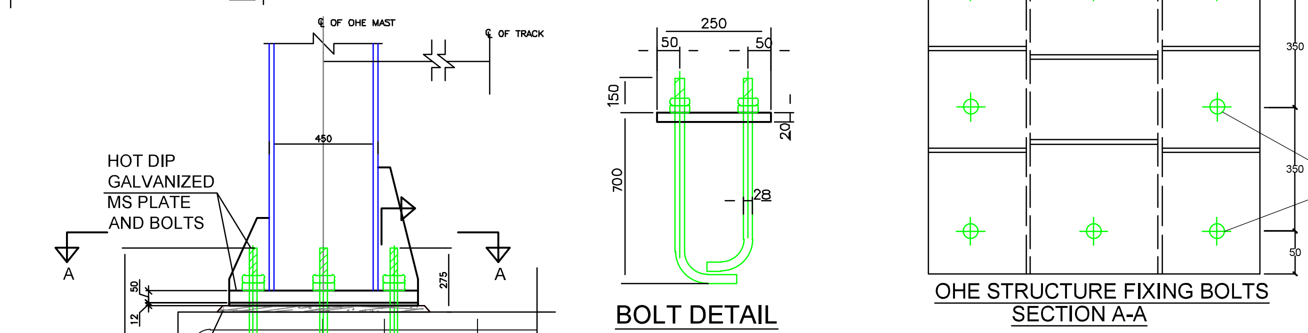
TITLE:- INDICATIVE OHE, EARTHING & BONDING ARRANGEMENT ON RCC BRIDGE/ VIADUCT

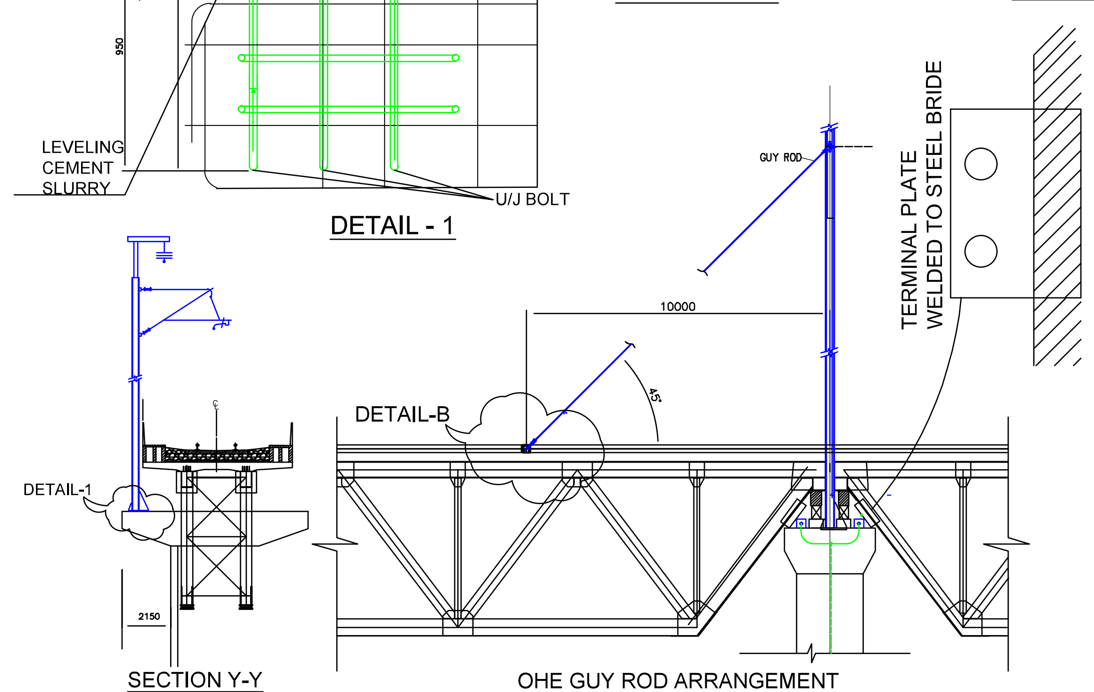
DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-006_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

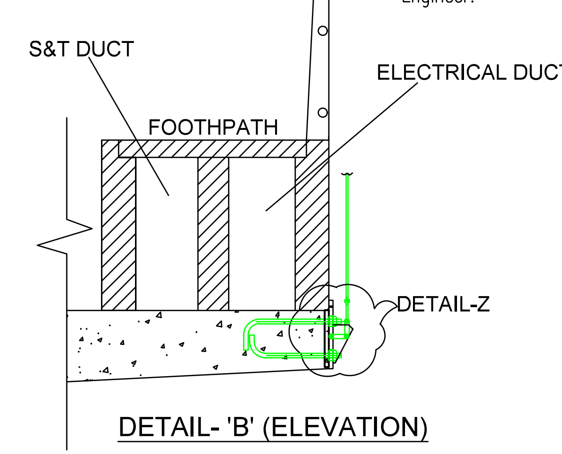
GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		











NOTE :

1. THE FOUNDATION BOLTS & CONCRETE FOR GUY ROD SHALL BE EMBEDED BY CIVIL CONTRACTOR IN THE DECK SLAB AS SHOWN.
2. ANCHOR BOLT SHALL TAKE MINIMUM TENSION OF 1000 KG.
3. Sizes are indicative and minimum,however contractor may be required to provide higher sizes as approved by the Engineer.

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

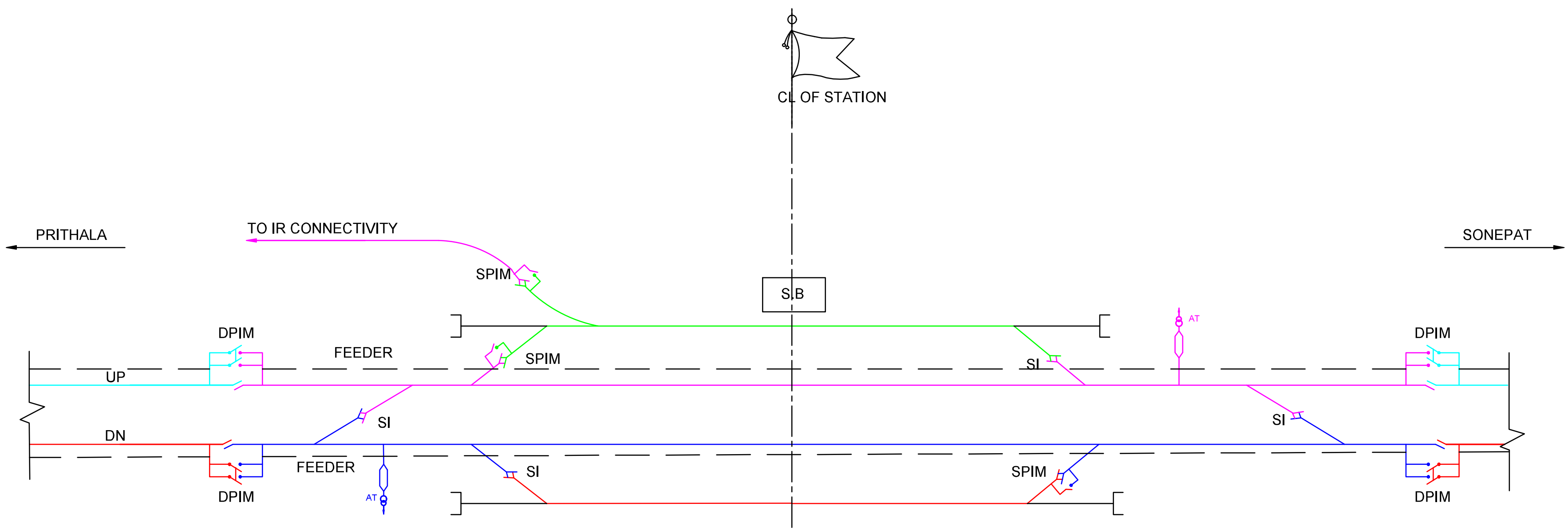
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE OHE GUY ROD ARRANGEMENT ON STEEL BRIDGE/ VIADUCT

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-007_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	



LEGEND:	
	DOUBLE POLE ISOLATOR (MOTORISED)
	SINGLE POLE ISOLATOR (MOTORISED)
	SECTION INSULATOR
	AUXILIARY TRANSFORMER

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

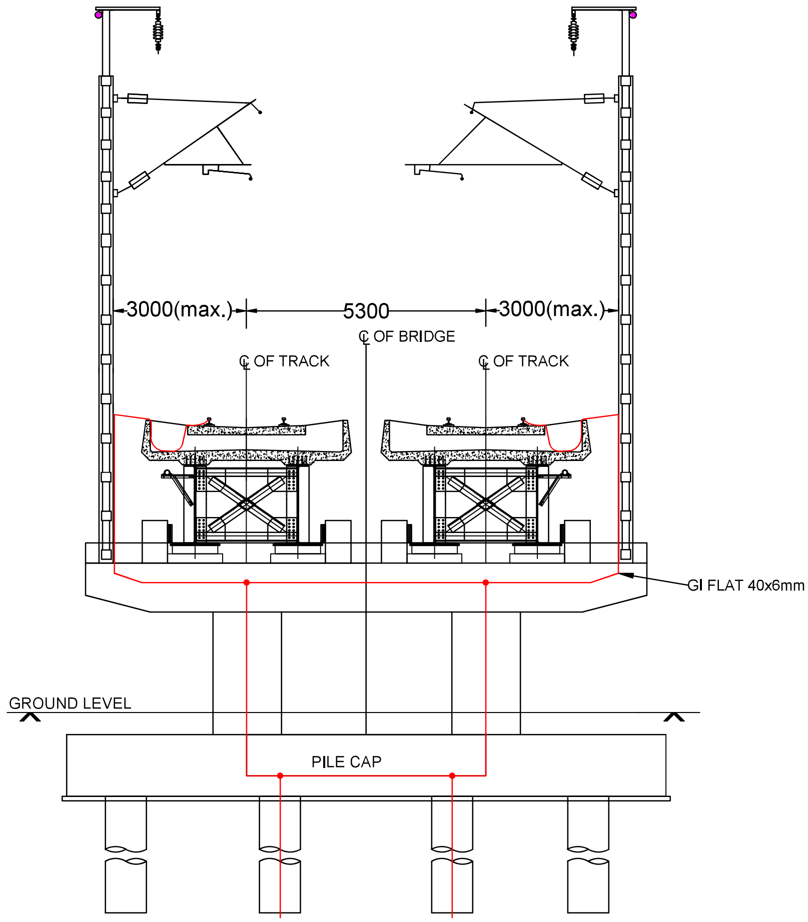
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE TYPICAL SECTIONING ARRANGEMENT OF STATION

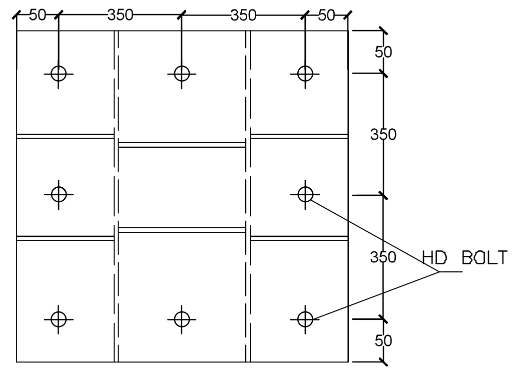
DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-008_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

NOTE:

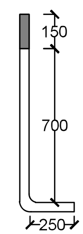
1. EACH MAST SHALL BE CONNECTED TO RAIL BY 40x6mm GI FLAT.



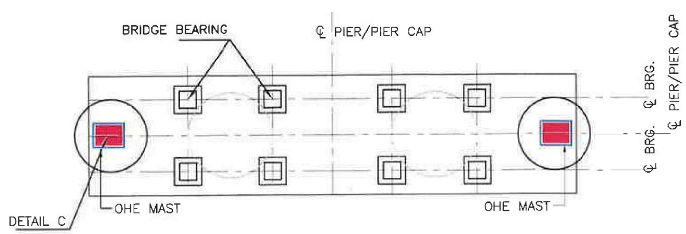
SECTION SHOWING LOCATIONS OF AEC, BEC AND THEIR INTER CONNECTIONS TO STEEL OHE MAST



OHE STRUCTURE FIXING BOLTS
SECTION A-A



BOLT DETAIL



PLAN AT PIER CAP LEVEL WITH OHE MAST BASE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

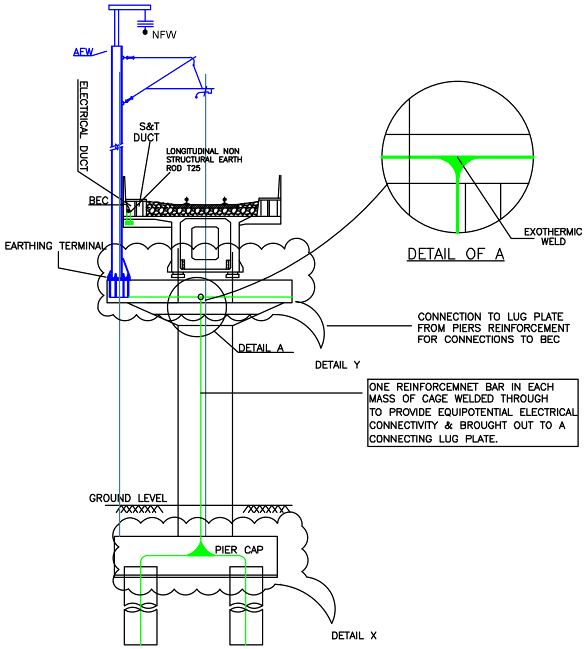
PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

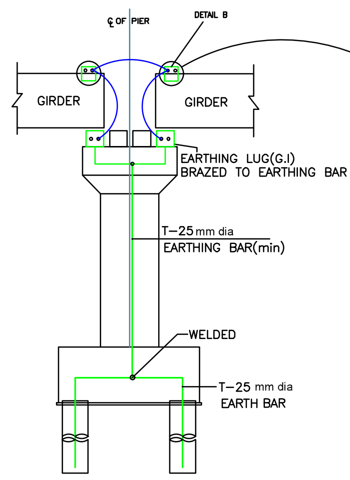
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

TITLE:- INDICATIVE OHE MAST ON GIRDER BRIDGE WITH EARTHING

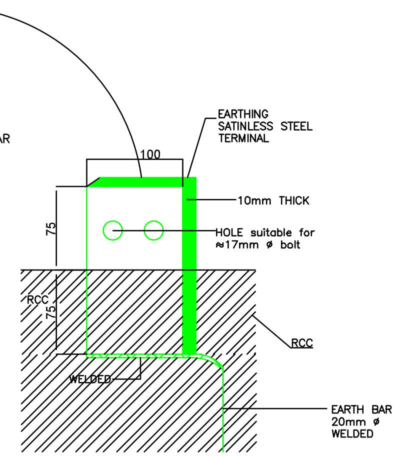
DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-009_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	



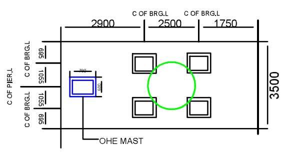
SECTION SHOWING LOCATIONS OF AEW,BEC AND THEIR INTER CONNECTIONS TO STEEL OHE MAST



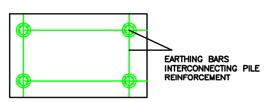
EARTHING & INTERCONNECTION OF EARTH TERMINALS OF RCC DECKS



TERMINAL PLATE DETAIL OF B



PLAN AT PIER CAP LEVEL WITH OHE MAST(TYPICAL)



DETAIL OF X

Colour Code

- Earthing
- OHE (LIVE)
- OHE (PARTS)

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	[signature]	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

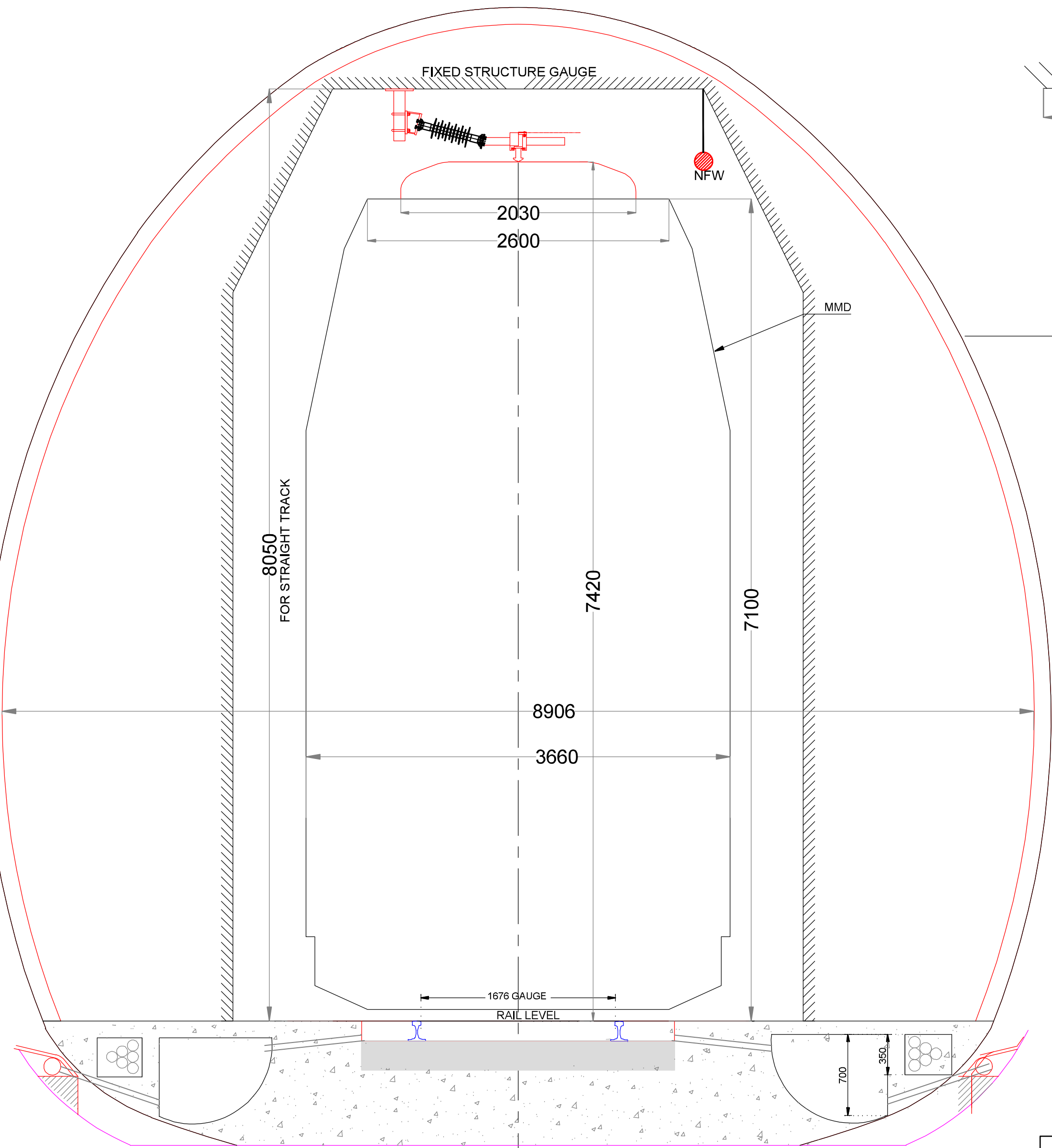
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

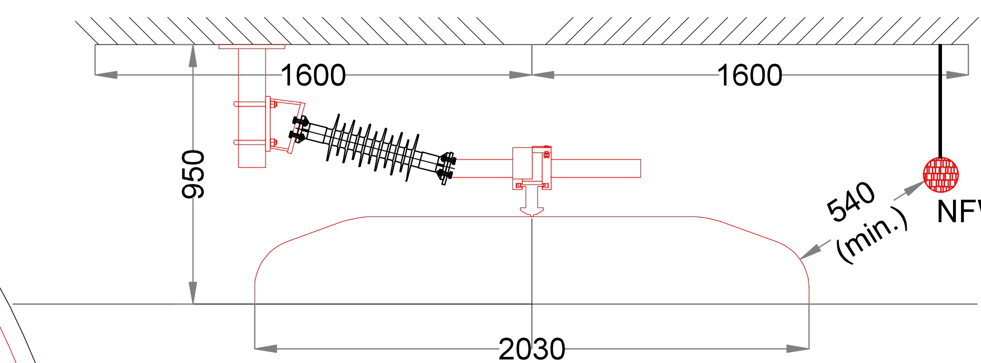
RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE EARTHING & BONDING OF OHE STRUCTURE ALONG THE BRIDGE, GIRDERS (RCC) & PIERS

DRG. NO.			SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-010_A0			
SCALE :		ISSUE DATE	REVISED DATE
AS SHOWN		31.03.2023	



FIXED STRUCTURE GAUGE



DETAILS OF 'A'

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

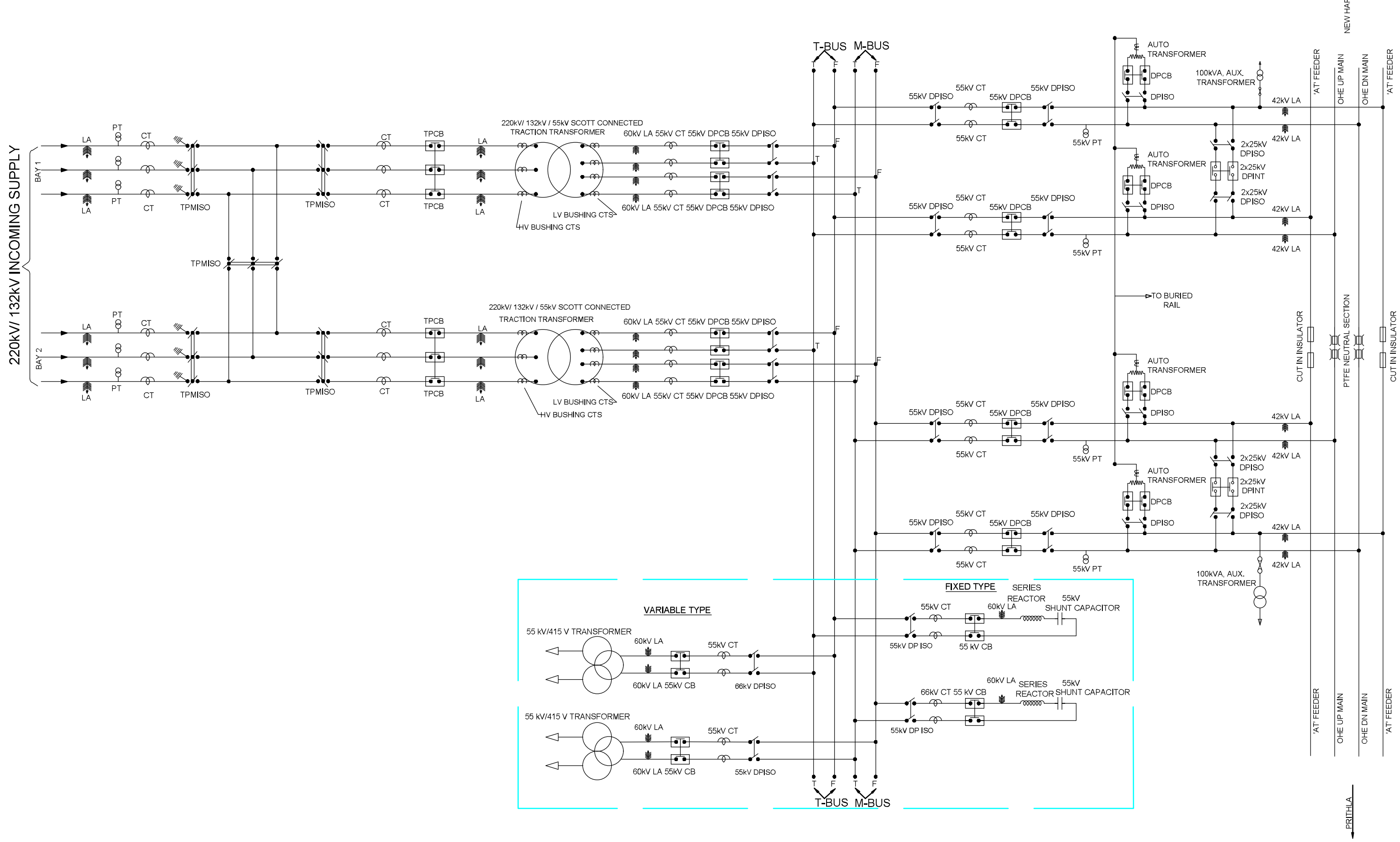
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE 2x25 KV HIGH RISE ROCS IN TUNNEL

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-011_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

SCHEMATIC DIAGRAM OF 220/132/55kV OF TSS
PRITHLA - HARSANA KALAN SECTION



LEGEND

DESCRIPTION	SLD SYMBOL
220/ 132kV TRIPLE POLE MOTORIZED ISOLATOR WITH EARTH SWITCH	
220/ 132kV TRIPLE POLE MOTORIZED ISOLATOR WITHOUT EARTH SWITCH	
220/ 132kV CURRENT TRANSFORMER	
220/ 132kV POTENTIAL TRANSFORMER	
220/ 132kV TRIPLE POLE SF6 CIRCUIT BREAKER	
LIGHTNING ARRESTER	
SCOTT-CONNECTED TRACTION TRANSFORMER	
60kV, LIGHTNING ARRESTER	
55kV, CURRENT TRANSFORMER	

DESCRIPTION	SLD SYMBOL
55kV, DOUBLE POLE CIRCUIT BREAKER	
55kV (or) 25kV, DOUBLE POLE ISOLATOR (MANUAL)	
55kV, POTENTIAL TRANSFORMER	
12.3 MVA, 55kV/27.5kV AUTO TRANSFORMER	
25kV, DOUBLE POLE INTERRUPTER	
55kV SHUNT CAPACITOR BANK	
55kV SERIES REACTOR DETUNED	
55kV/ 415 V COUPLING TRANSFORMER (FOR PFC)	
25 kV/240V 100kVA LT SUPPLY TRANSFORMER	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	[signature]	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

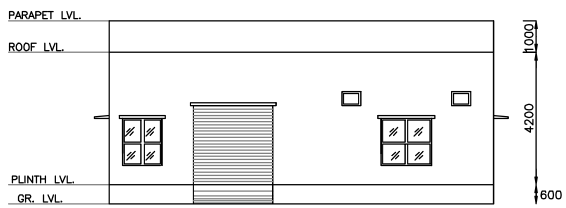
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.
RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

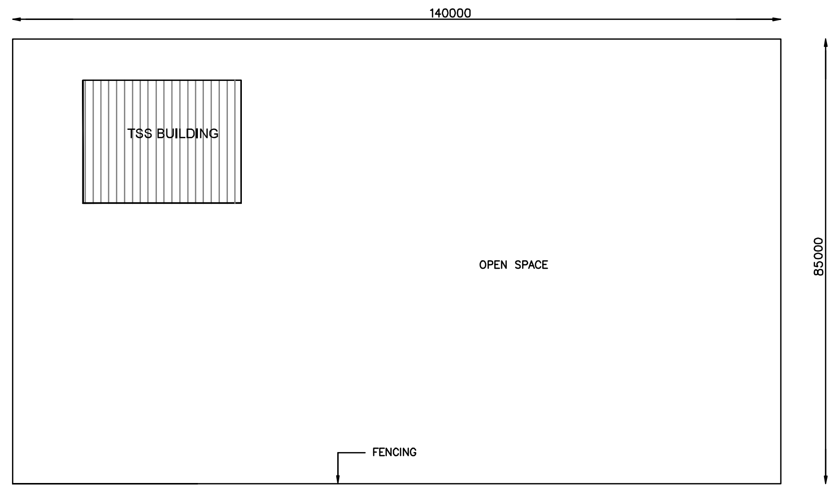
TITLE:-INDICATIVE SINGLE LINE DIAGRAM OF TRACTION SUBSTATION 220/132/2x25kV SCOTT CONNECTED TRAMSFORMER

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-012_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

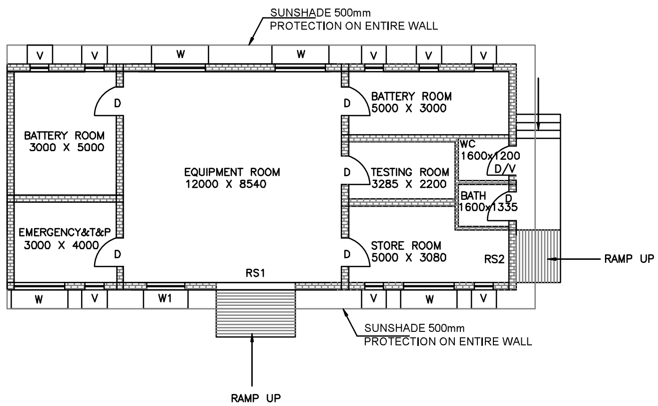
INDICATIVE CONTROL ROOM AT TRACTION SUB-STATION



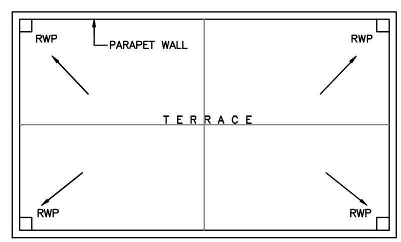
ELEVATION



LAYOUT PLAN



GROUND FLOOR PLAN



TERRACE PLAN

Note:-
1. All the dimensions in the drawing are indicative.
2. Provision of Meter Room should also be kept along with Rooms indicated above.

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

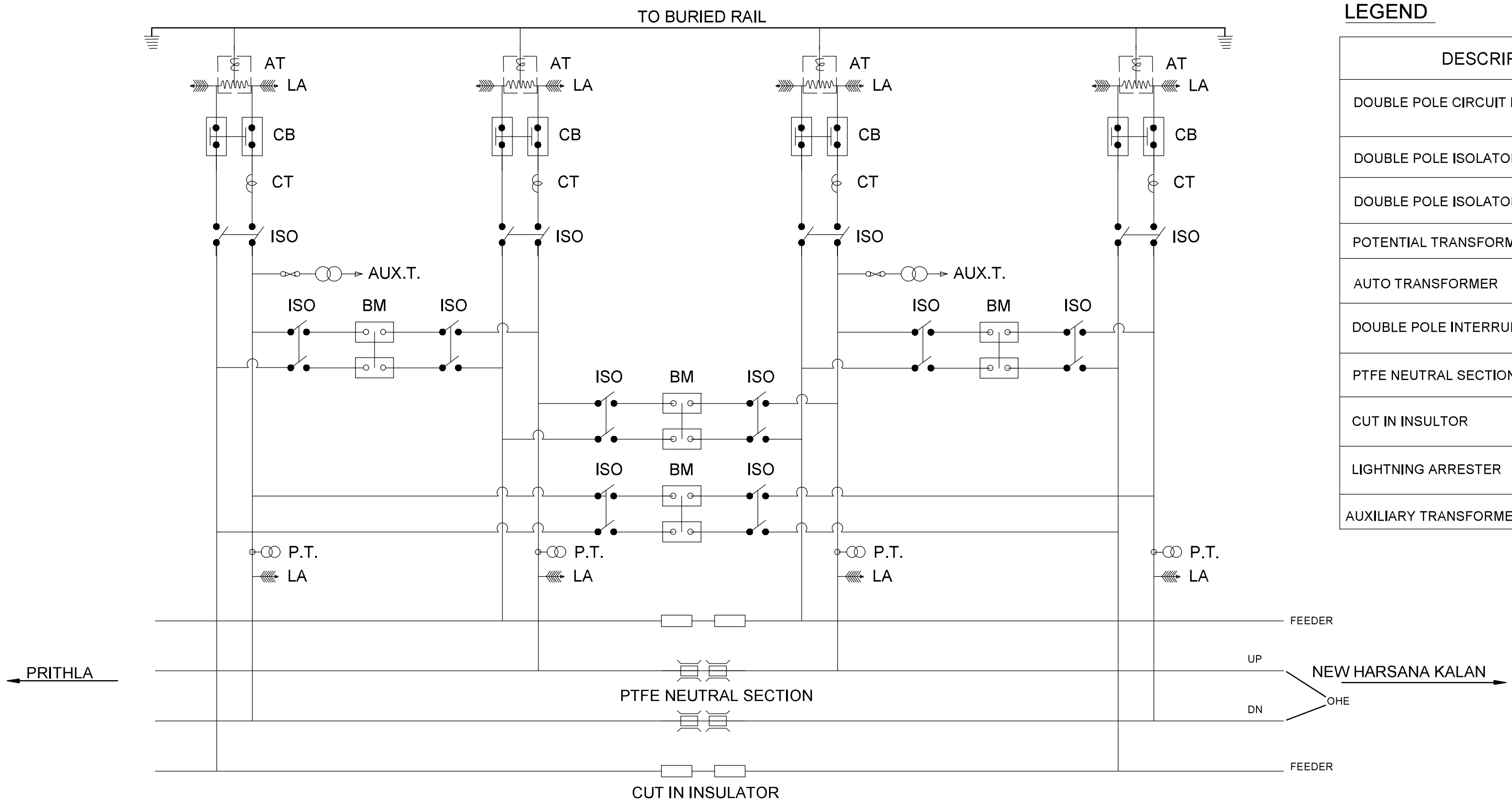
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE CONTROL ROOM AT TSS

DRG. NO. GC-HRIDC-SYS1-DRW-ELE-013_A0		SHEET NO.
SCALE : AS SHOWN	ISSUE DATE 31.03.2023	REVISED DATE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		



LEGEND

DESCRIPTION	SLD SYMBOL
DOUBLE POLE CIRCUIT BREAKER	
DOUBLE POLE ISOLATOR	
DOUBLE POLE ISOLATOR (MOTORISED)	
POTENTIAL TRANSFORMER	
AUTO TRANSFORMER	
DOUBLE POLE INTERRUPTER	
PTFE NEUTRAL SECTION	
CUT IN INSULTOR	
LIGHTNING ARRESTER	
AUXILIARY TRANSFORMER	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

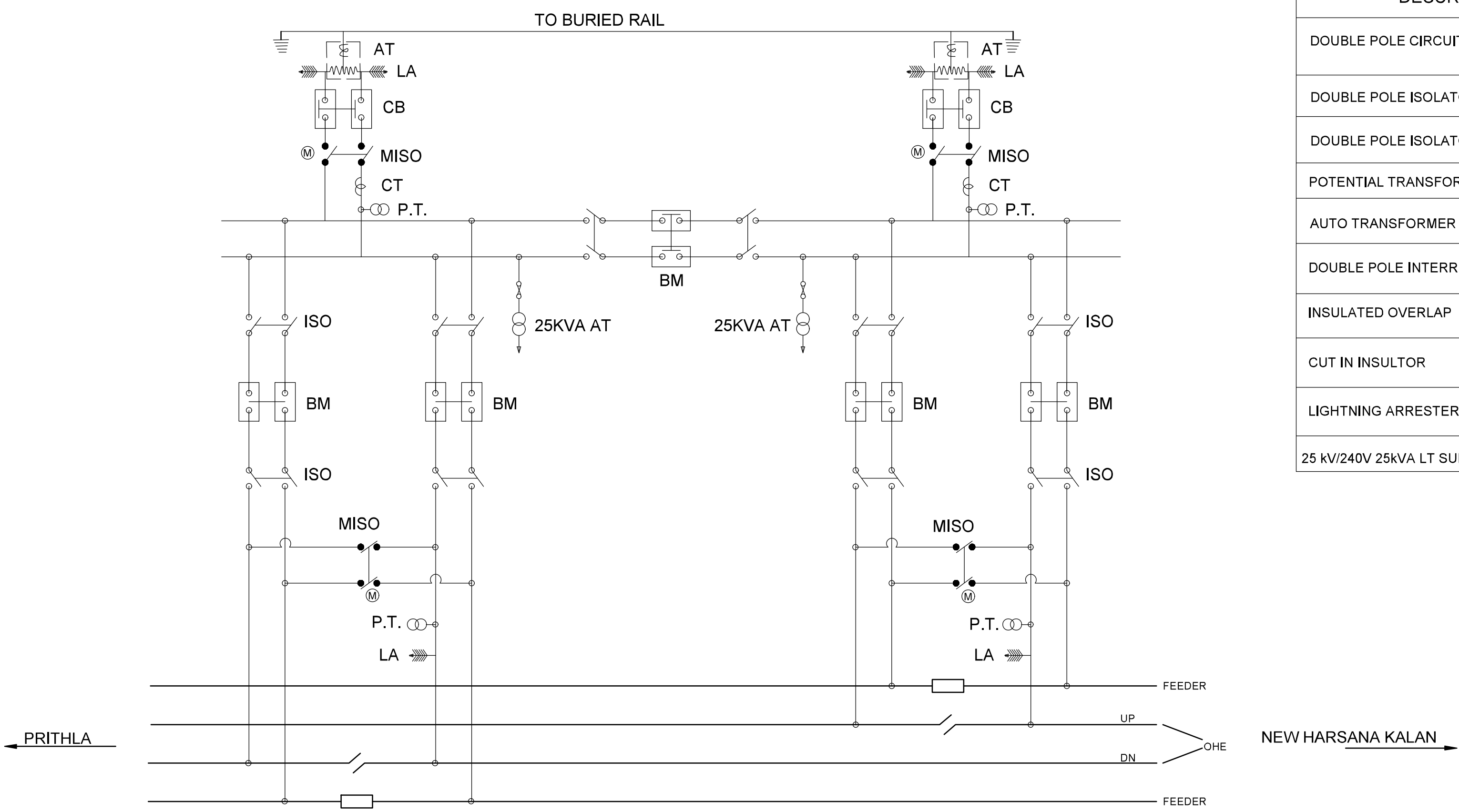
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE SINGLE LINE DIAGRAM OF SECTIONING POST (SP)

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

DRG. NO.			SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-014_A0			
SCALE :	ISSUE DATE	REVISED DATE	
AS SHOWN	31.03.2023		



LEGEND

DESCRIPTION	SLD SYMBOL
DOUBLE POLE CIRCUIT BREAKER	
DOUBLE POLE ISOLATOR	
DOUBLE POLE ISOLATOR (MOTORISED)	
POTENTIAL TRANSFORMER	
AUTO TRANSFORMER	
DOUBLE POLE INTERRUPTER	
INSULATED OVERLAP	
CUT IN INSULTOR	
LIGHTNING ARRESTER	
25 kV/240V 25kVA LT SUPPLY TRANSFORMER	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

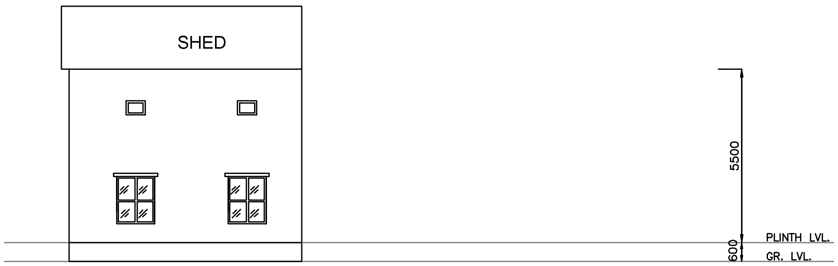
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

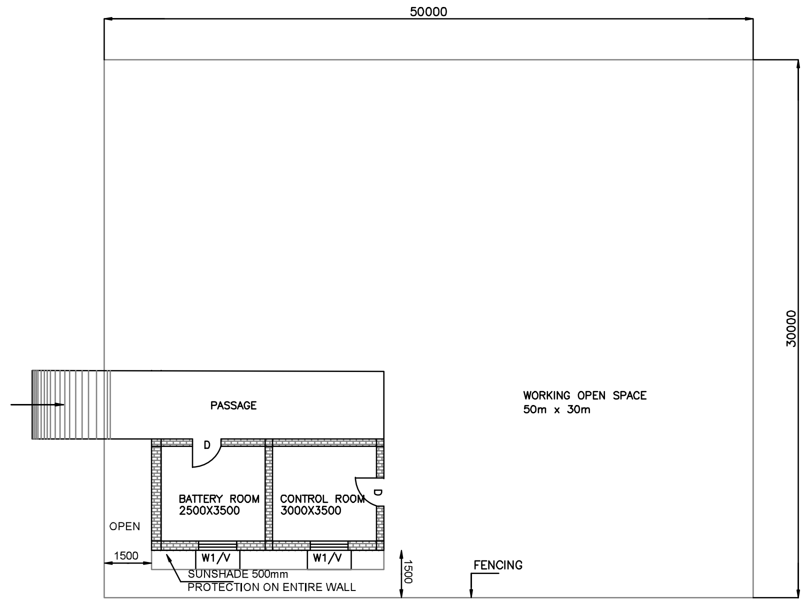
TITLE:- INDICATIVE SINGLE LINE DIAGRAM OF SUB-SECTIONING POST (SSP)

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-015_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

SP & SSP PLAN AND ELEVATION



ELEVATION



GROUND FLOOR PLAN

Note:-

1. All the dimensions in the drawing are indicative.

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

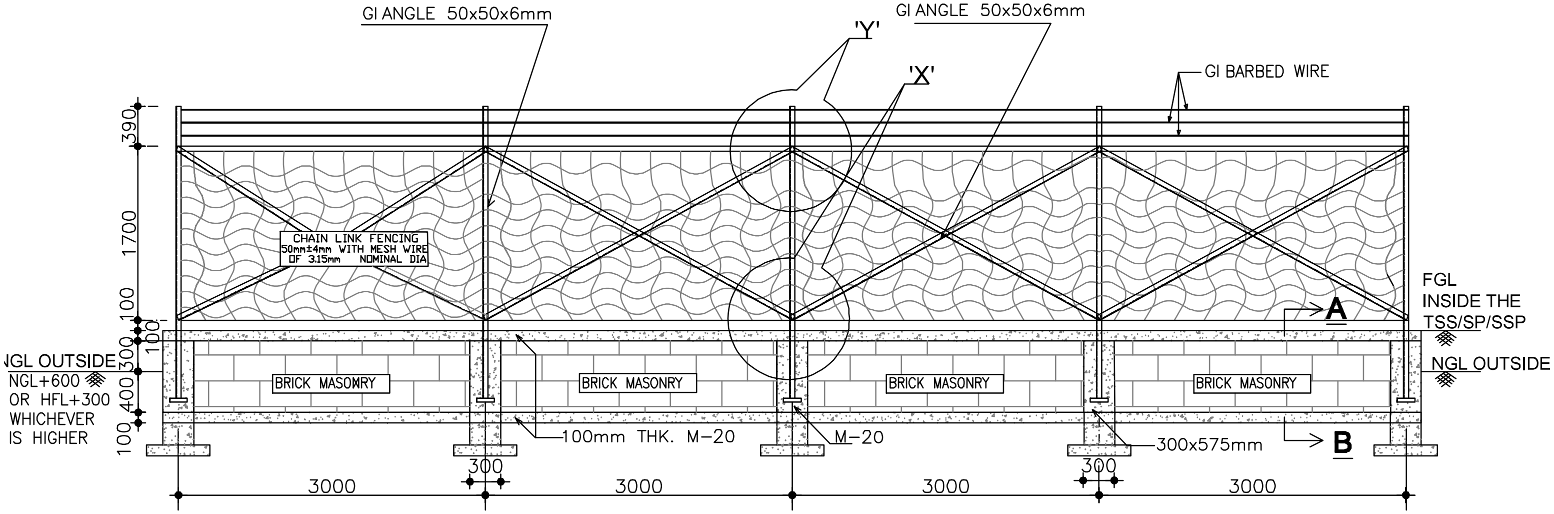
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE PLAN AND ELEVATION FOR SP & SSP

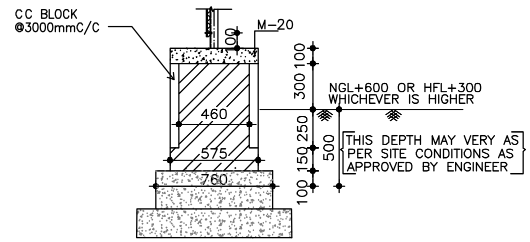
GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

DRG. NO.			SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-016_A0			
SCALE :		ISSUE DATE	REVISED DATE
AS SHOWN		31.03.2023	

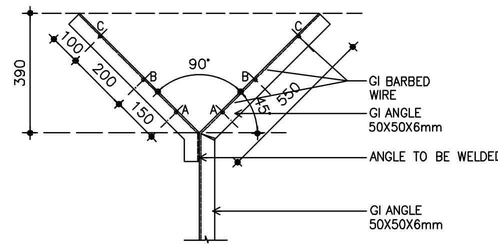


TYPICAL DRAWING FOR CHAIN LINK FENCING

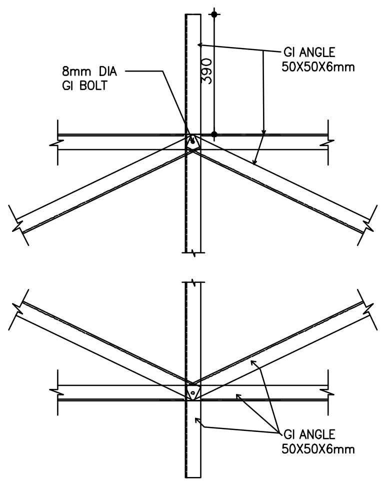
NOTES:
1. ALL DIMENSIONS ARE IN MILIMETERS UNLESS NOTES OTHERWISE.
2. WRITTEN DIMENSIONS ARE TO BE FOLLOWED. DRAWINGS ARE NOT TO BE SCALED.
3. ANY DISCREPANCY IN THE DRAWING SHALL BE BROUGHT TO THE NOTICE OF ENGINEER.
4. EXPANSION JOINT IN MASONRY AND ALSO IN CHAIN LINK SHOULD BE PROVIDED AT REGULAR INTERVAL OF (30m C/C).
5. THE MESH SIZE OF CHAIN LINK SHOULD BE 50mm (+/-) 4mm AND MESH WIRE SHOULD HAVE NOMINAL DIAMETER OF 3.15mm.
6. DEPTH OF FOUNDATION BELOW FILLED UP LEVEL IS TENTATIVE. THIS MAY BE INCREASED BY ENGINEER AS PER SITE CONDITION.
7. THE LOCATION AND STATION, WHERE THIS CHAIN LINK FENCING IS TO BE PROVIDED, WILL BE AS PER EMPLOYER'S REQUIREMENTS.
8. WIRE MESH AND ANGLE SHALL BE PROPERLY FIXED WITH SUITABLE FIXTURE.
9. ALL Y- POST, BARBED WIRE, VERTICAL , HORIZONTAL AND DIAGONAL ANGLES ON TOP SHALL BE HOT DIPPED GALVANIZED IRON.



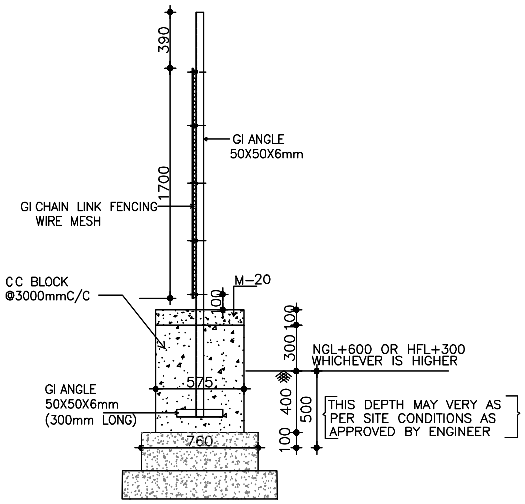
SECTION- A B



TYPICAL ARRANGEMENT OF Y - POST AND BARBED WIRE



DETAIL 'X' & 'Y'
TYPICAL FIXING ARRANGEMENT OF VERTICAL, HORIZONTAL & DIAGONAL ANGLES ON TOP



TYPICAL FIXING ARRANGEMENT OF FLAT TO HOLD CHAIN LINK FENCING

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

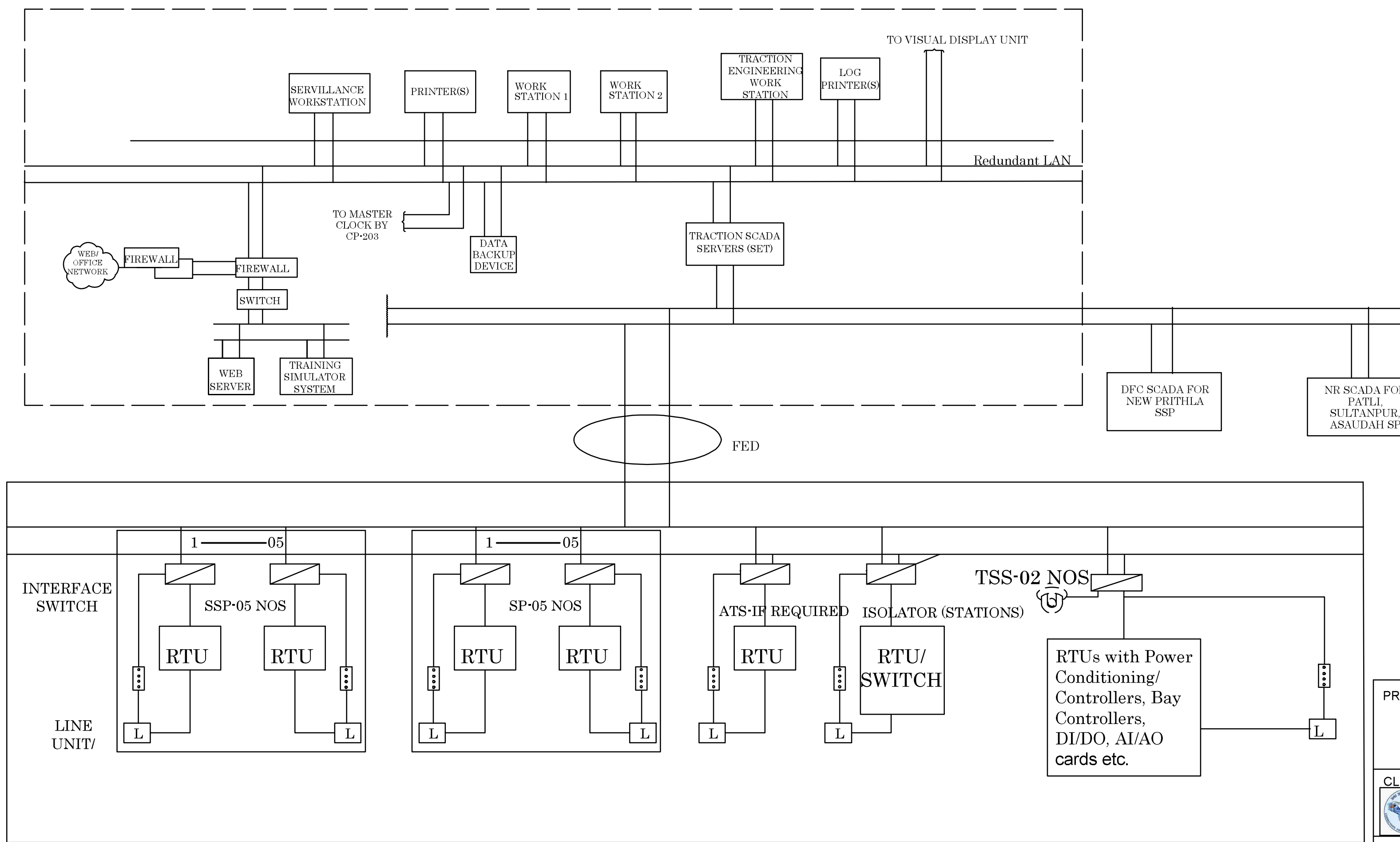
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE DRAWING FOR TSS/ SP/ SSP FENCING

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-017_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

OCC AND TRACTION SCADA ARRANGEMENT FOR PRITHLA - NEW HARSANA KALAN SECTION



LEGENDS

Communication Line Interface required for connecting SCADA Equipment with OFC ring/Switch

L - FAULT FACTOR

- MODEM

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	ChahateyRam	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	(signed)	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	(signed)		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

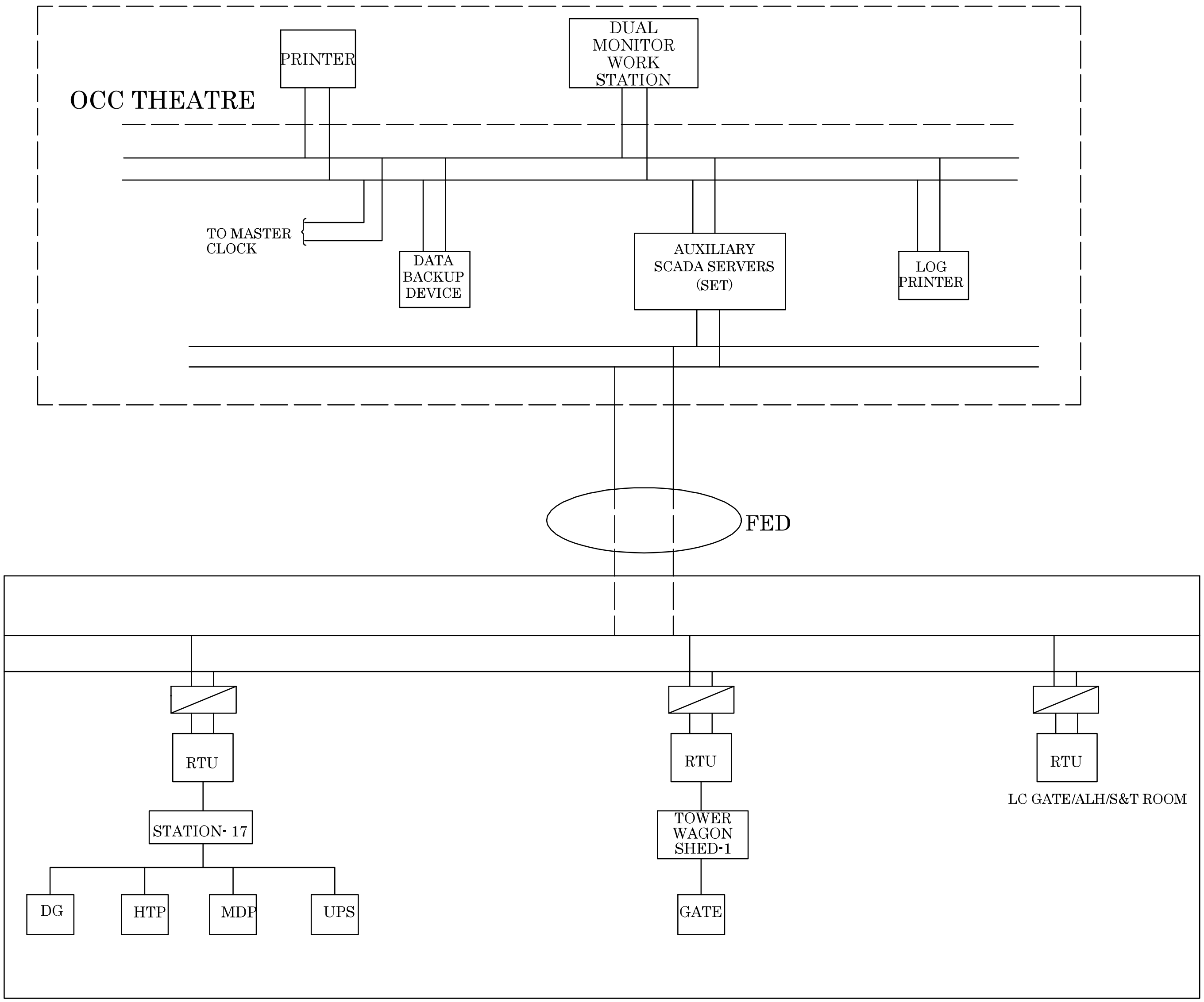
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE GENERAL ARRANGEMENT BLOCK DIAGRAM FOR TRACTION SCADA CONTROL

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-018_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

AUXILIARY SCADA SYSTEM FOR PRITHLA - NEW HARSANA KALAN SECTION



MDP	Main Distribution Panel
DG	Diesel Generator
HTP	High Tension Panel

:ion Line Interface as required for connecting SCADA Equipment
ng/switch shall be coordinated by the contractor.

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STEPHEN SAHOO SRE/Elect.			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

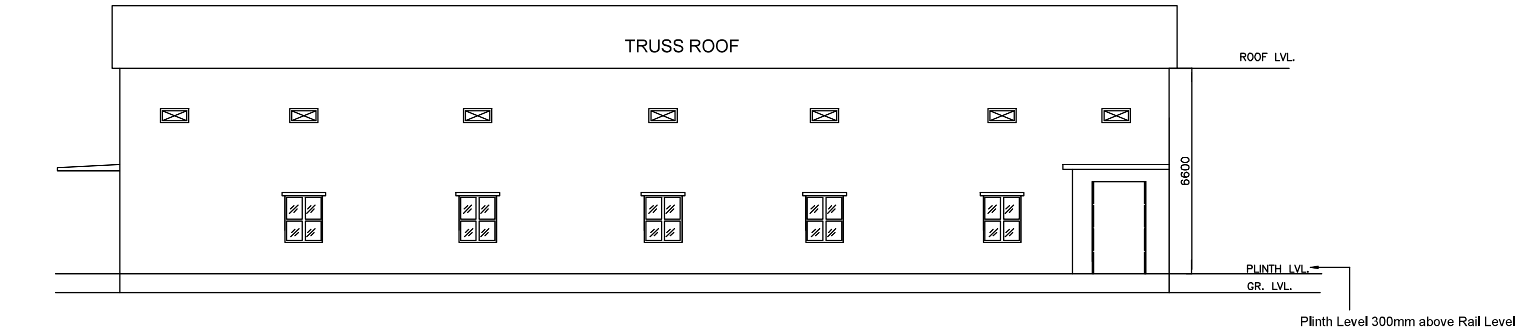
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

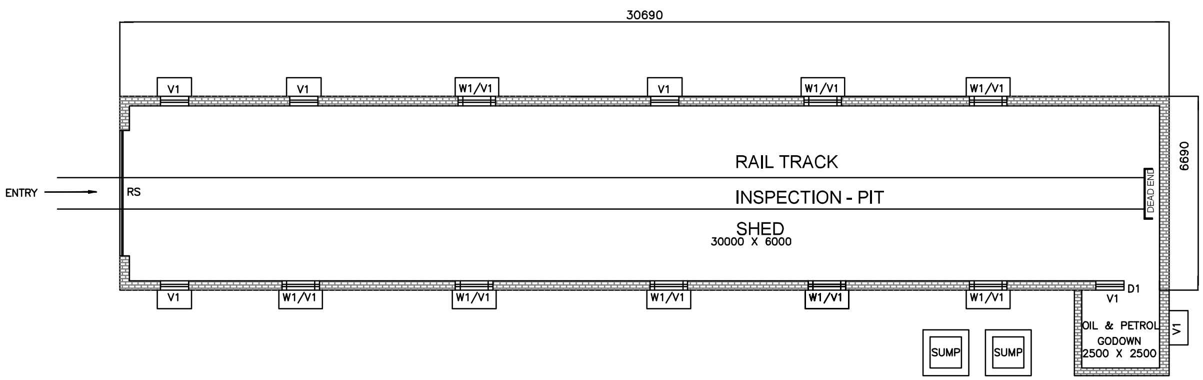
TITLE:- INDICATIVE GENERAL ARRANGEMENT BLOCK DIAGRAM FOR AUXILIARY SCADA CONTROL

DRG. NO.			SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-019_A0			
SCALE :	ISSUE DATE	REVISED DATE	
AS SHOWN	31.03.2023		

TOWER WAGON SHED PLAN AND ELEVATION



ELEVATION



GROUND FLOOR PLAN

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

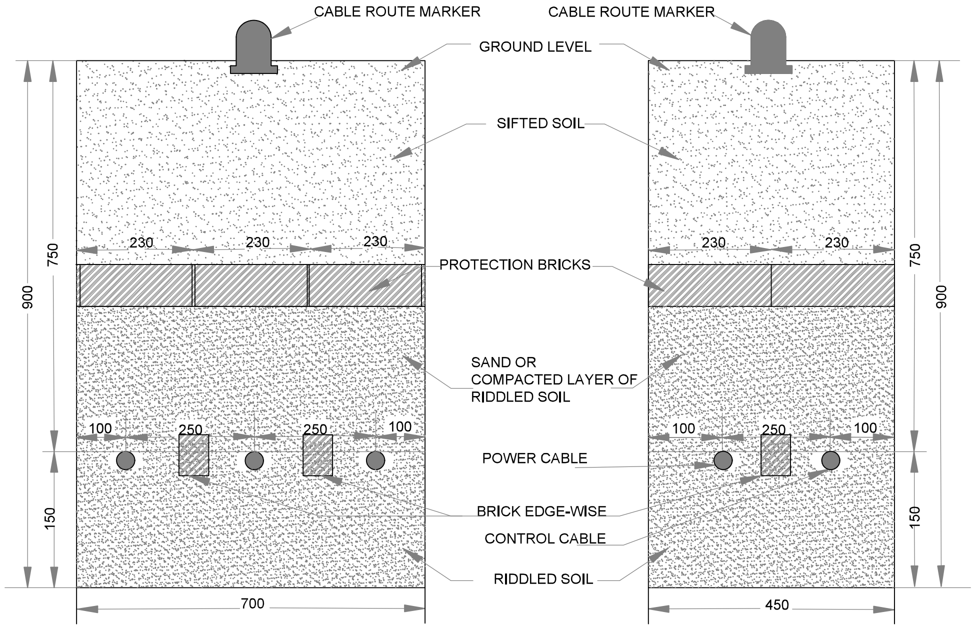
RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

TITLE:- INDICATIVE PLAN AND ELEVATION FOR TOWER WAGON SHED

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	ChahateyRam	VIKRAM YADAV GM/ A&E/ HRIDC	
A.S. JANGHU CRE/Elect.	[signature]	JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.	[signature]		

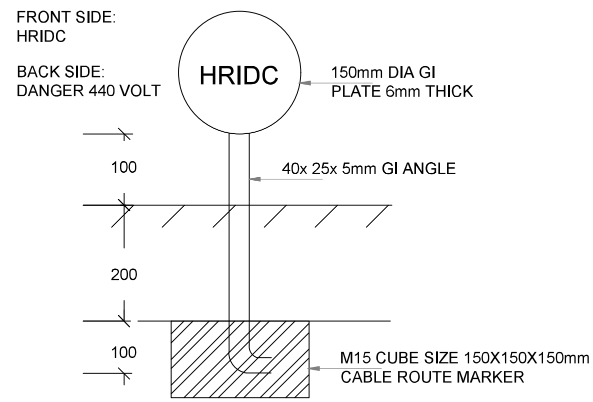
DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-020_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

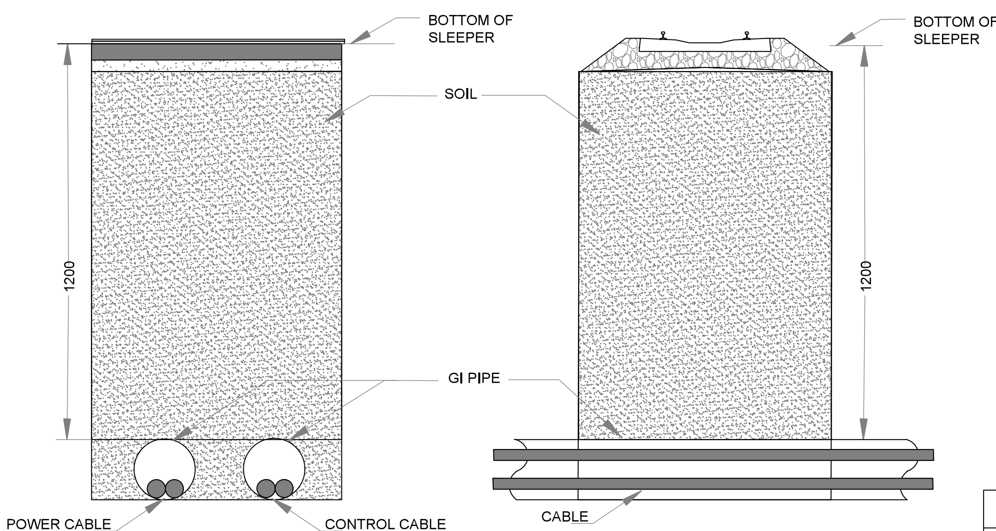
CABLE PATH IN OPEN | CABLE PATH IN OPEN



NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRE.
2. ROUTE MARKER SHALL BE PROVIDED AT EVERY 100m AND ON CHANGE OF DIRECTION OF CABLE ROUTE.
3. FOR TRACK CROSSING GI PIPE 75mm DIA (MIN.) SHALL BE USED.
4. FOR CABLES PASSING BELOW FLOOR, ROAD, PLATFORM ETC HDPE PIPE 63mm DIA (MIN.) PN4 SHALL BE USED.





ACROSS THE TRACK | **ACROSS THE TRACK**

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		VIKRAM YADAV GM/ A&IE/ HRIDC	
A.S. JANGHU CRE/Elect.		JYOTI SANGWAN DGM/ Elect.	
STIPHEN SAHOO SRE/Elect.			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

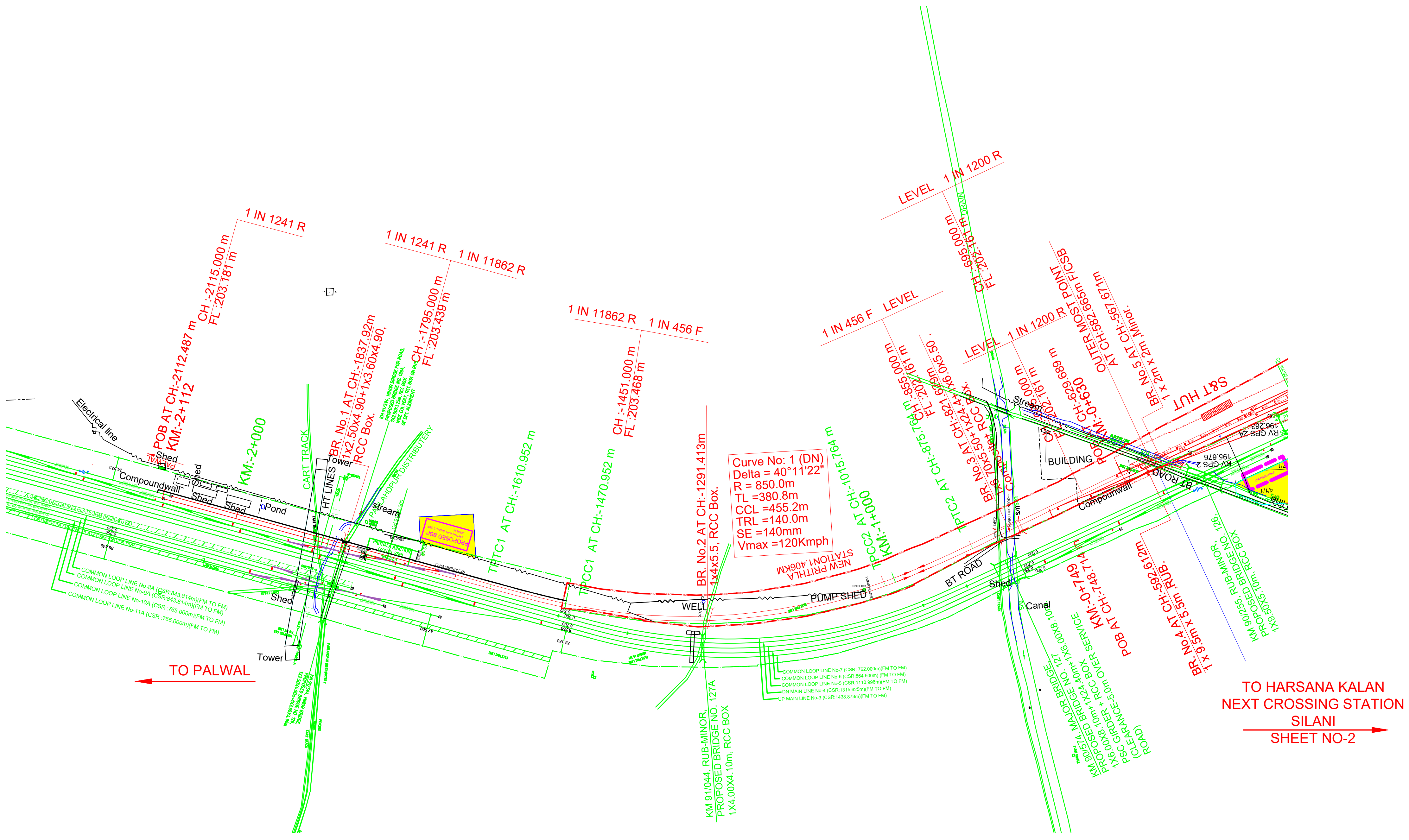
CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

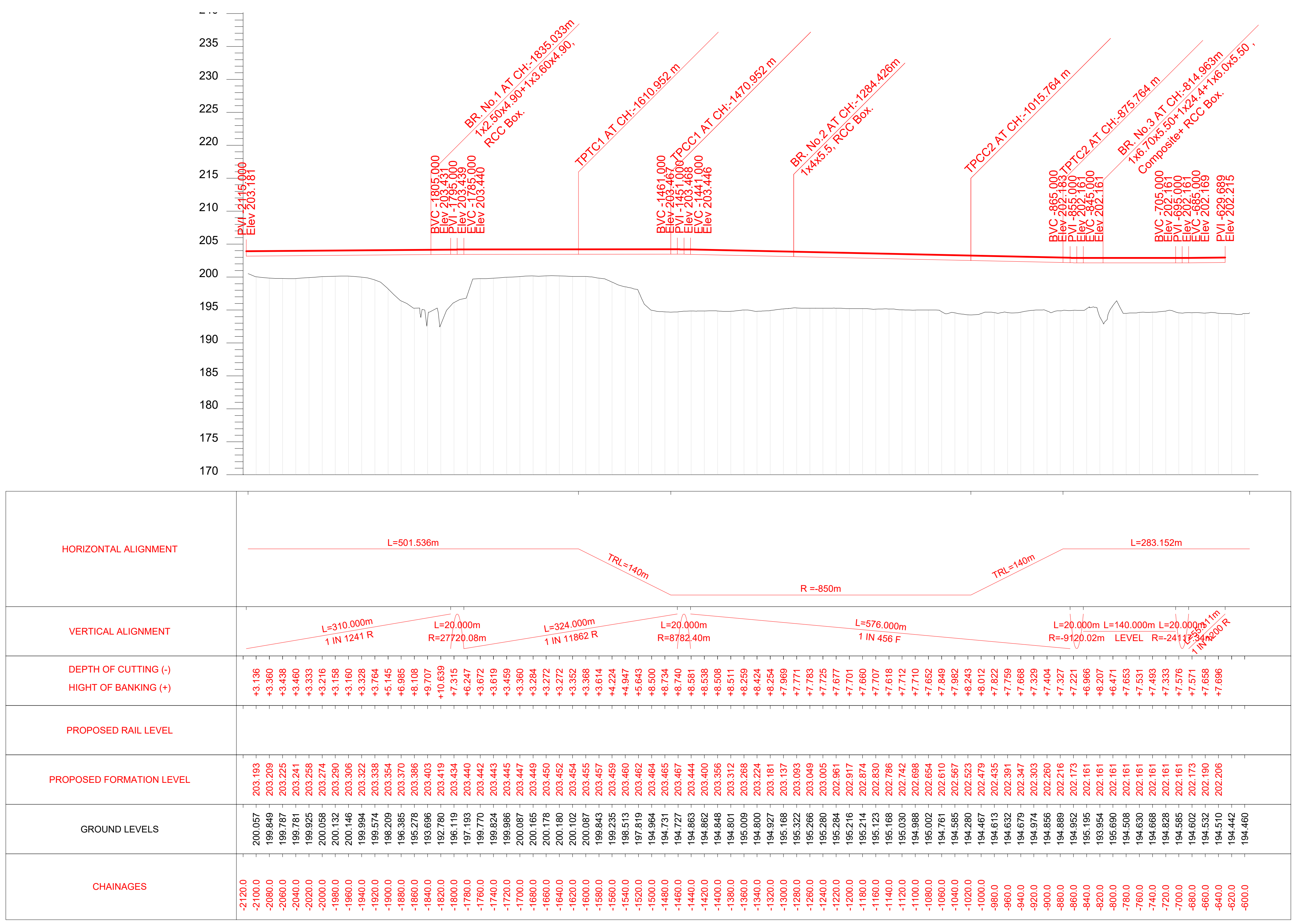
CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

TITLE:- INDICATIVE CABLE ROUTE PLAN FOR MOTORISED ISOLATOR

DRG. NO.		SHEET NO.
GC-HRIDC-SYS1-DRW-ELE-021_A0		
SCALE :	ISSUE DATE	REVISED DATE
AS SHOWN	31.03.2023	

B. Civil Drawings





LONGITUDINAL PROFILE

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC	
NAME / DESIGNATION	SIGN
SHIV OM DWIVEDI *CPM/HRIDC*	
RAJU SOLANKI *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (-2.12 KM TO -0.6 KM)

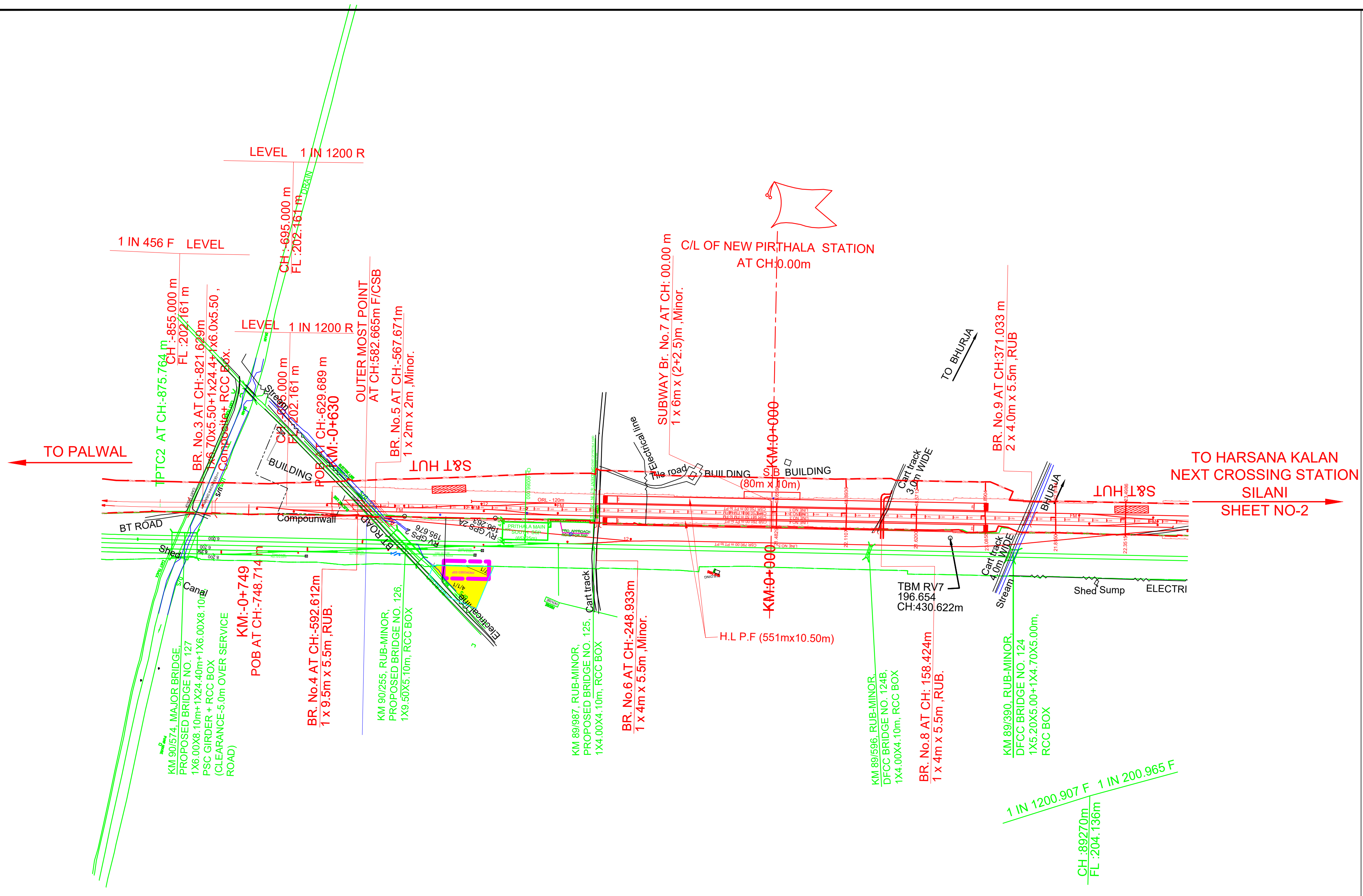
GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-(-2.12)-(-0.6)KM_A0

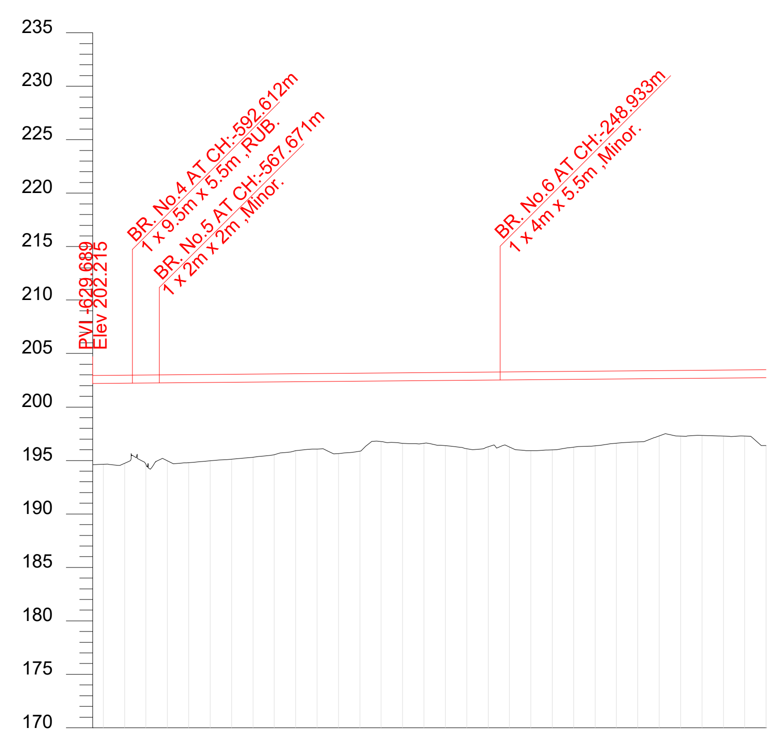
ISSUE Dt: 25.02.2023 | REVISED Dt:

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3	SHEET No. 1 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022





HORIZONTAL ALIGNMENT: L=1544.246m

VERTICAL ALIGNMENT: L=1478.535m, 1 IN 1200 R

CHAINAGES	GROUND LEVELS	PROPOSED FORMATION LEVEL	PROPOSED RAIL LEVEL	DEPTH OF CUTTING (-) / HIGHT OF BANKING (+)
-629.7	194.610			
-620.0	194.635	202.223	202.965	+7.588
-600.0	194.741	202.240	202.982	+7.499
-580.0	194.654	202.257	202.999	+7.603
-560.0	194.973	202.273	203.015	+7.300
-540.0	194.805	202.290	203.032	+7.485
-520.0	194.969	202.307	203.049	+7.338
-500.0	195.118	202.323	203.065	+7.205
-480.0	195.304	202.340	203.082	+7.036
-460.0	195.546	202.357	203.099	+6.811
-440.0	195.907	202.373	203.115	+6.466
-420.0	196.073	202.390	203.132	+6.317
-400.0	195.654	202.407	203.149	+6.753
-380.0	195.856	202.423	203.165	+6.567
-360.0	196.768	202.440	203.182	+5.672
-340.0	196.600	202.457	203.199	+5.857
-320.0	196.598	202.473	203.215	+5.875
-300.0	196.390	202.490	203.232	+6.100
-280.0	196.105	202.507	203.249	+6.402
-260.0	196.267	202.523	203.265	+6.256
-240.0	196.254	202.540	203.282	+6.286
-220.0	195.912	202.557	203.299	+6.645
-200.0	195.998	202.573	203.315	+6.575
-180.0	196.240	202.590	203.332	+6.350
-160.0	196.376	202.607	203.349	+6.231
-140.0	196.615	202.623	203.365	+6.008
-120.0	196.739	202.640	203.382	+5.901
-100.0	197.299	202.657	203.399	+5.358
-80.0	197.283	202.673	203.415	+5.390
-60.0	197.332	202.690	203.432	+5.358
-40.0	197.274	202.707	203.449	+5.433
-20.0	197.282	202.723	203.465	+5.441
0.0	196.393	202.740	203.482	+6.347

LONGITUDINAL PROFILE

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CENTRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- TRACK = 60KG RAILS
- SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- BALLAST CUSHION : 350mm
- ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC	
NAME / DESIGNATION	SIGN
SHIV OM DWIVEDI *CPM/HRIDC*	
RAJU SOLANKI *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (-0.6 KM TO 0.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-(-0.6)-(0.0)KM_A0

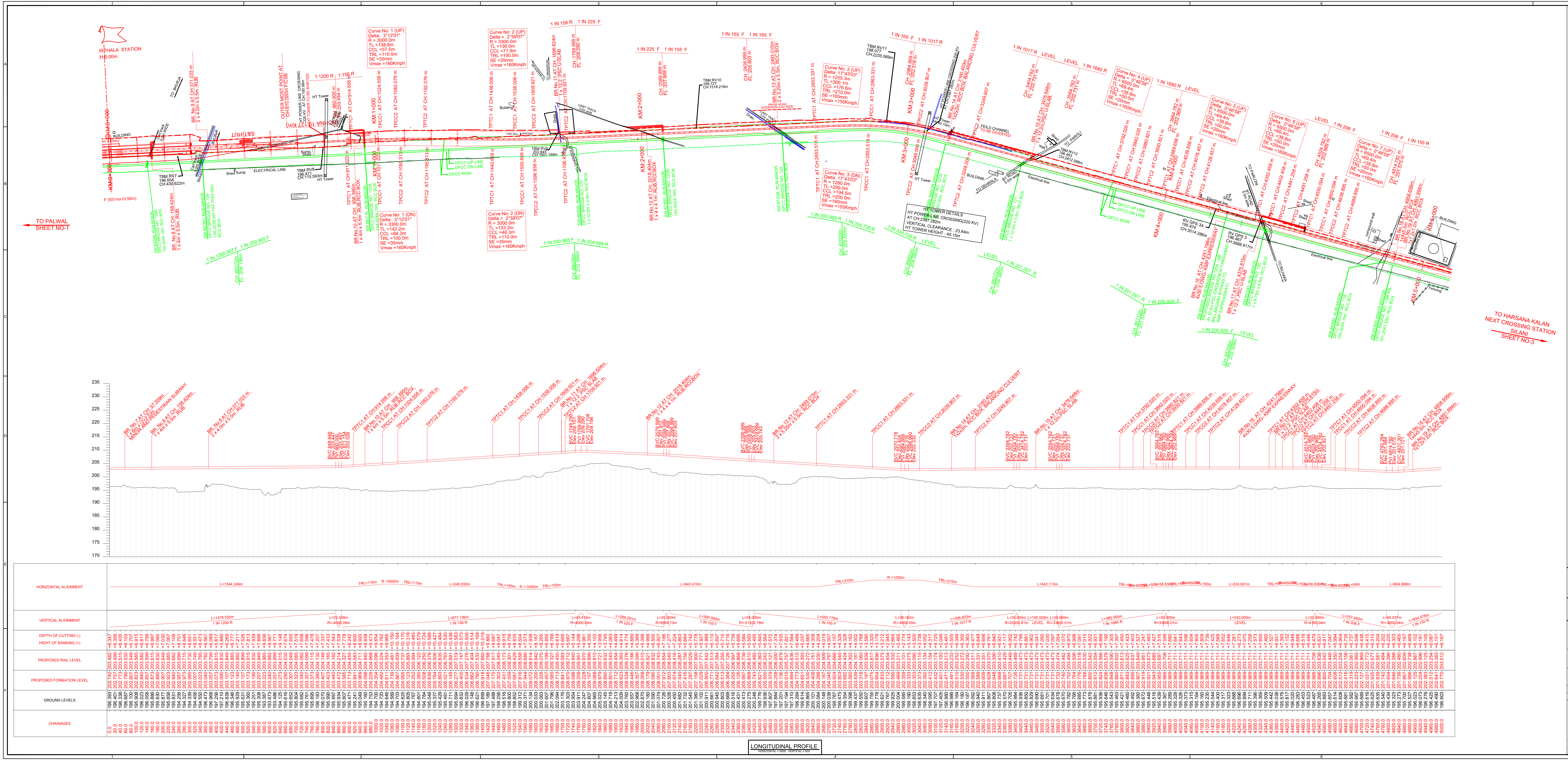
ISSUE Dt: 25.02.2023 | REVISED Dt:

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 2 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022



LEGEND:

EXISTING RAILWAY TRACK
PROPOSED UP & DN LINE
DISMANTLING WORKS
PROPOSED DIVERSIONS
EXISTING ROAD
PRO.HORC BOUNDARY
EXPRESSWAY BOUNDARY
HT LINE
ELECTRICAL LINE(LT)
STREAM / CANAL / DRAIN
WELL
POND
PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE
PROPOSED FORMATION PROFILE
GROUND PROFILE

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC	
NAME / DESIGNATION	SIGN
SHIV OM DWIVEDI *CPM/HRIDC*	
RAJU SOLANKI *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (0.0 KM TO 5.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-0-5KM_A0

ISSUE Dt: 25.02.2023 | REVISED Dt:

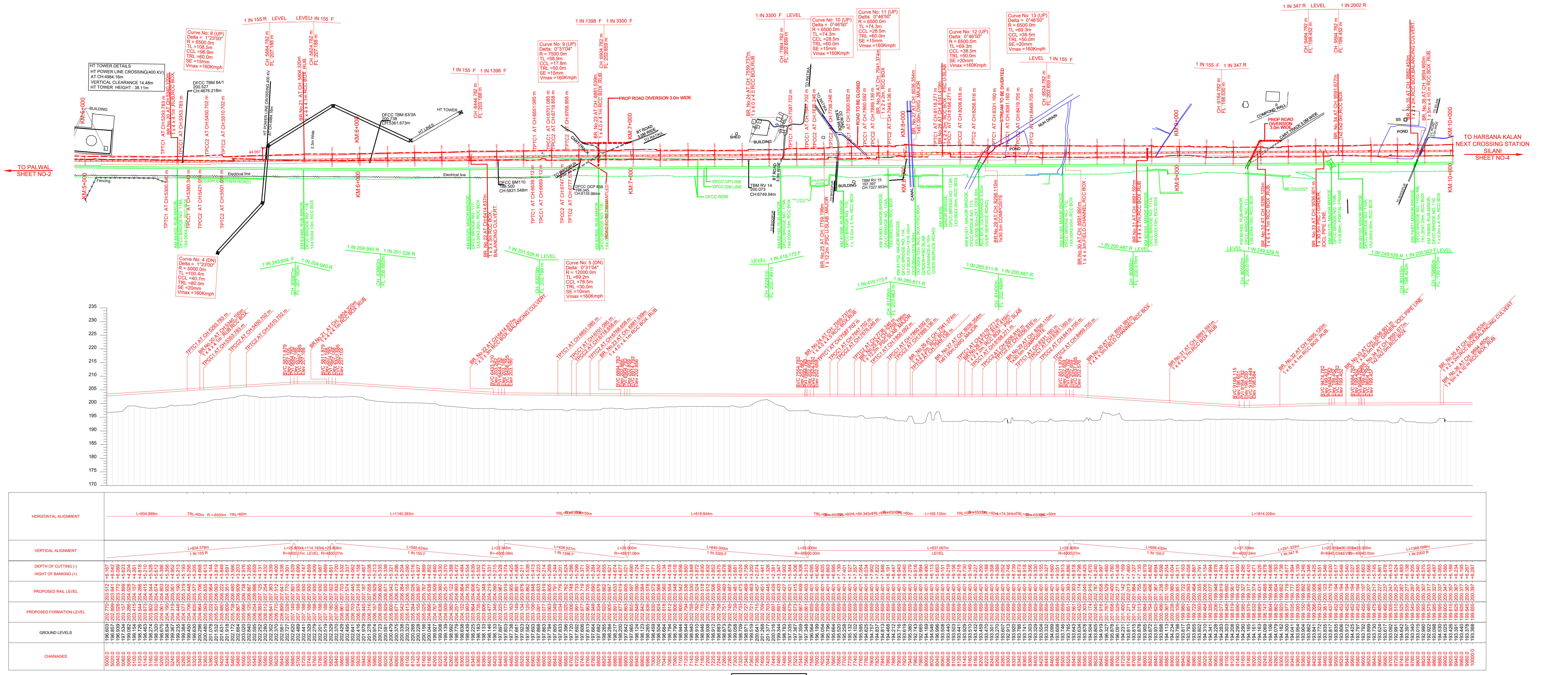
CONSULTANTS : aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 3 OF 24

SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022



LONGITUDINAL PROFILE

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC	
NAME / DESIGNATION	SIGN
SHIV OM DWIVEDI *CPM/HRIDC*	
RAJU SOLANKI *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (5.0 KM TO 10.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-5-10KM_A0

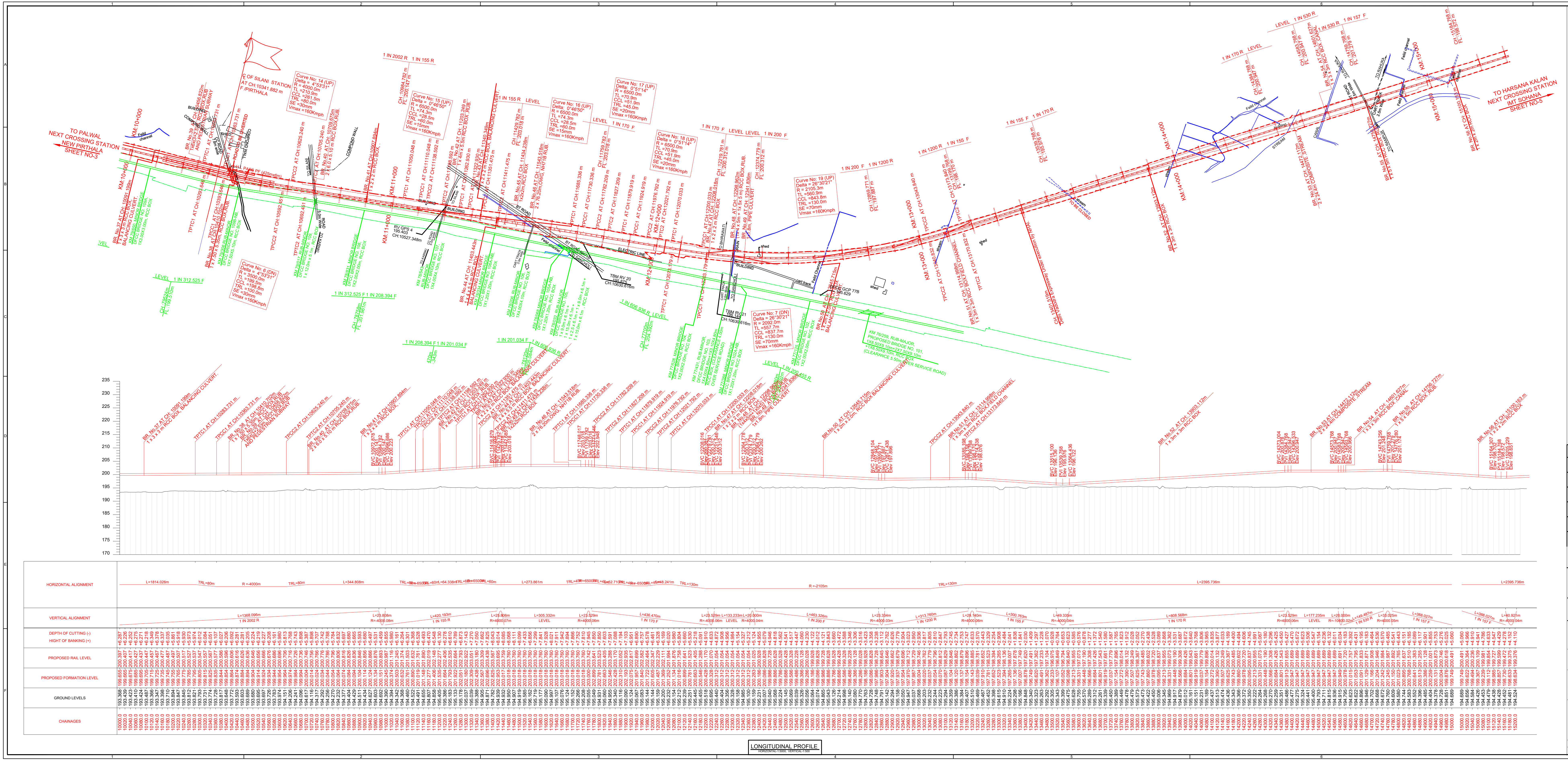
ISSUE Dt: 25.02.2023 | REVISED Dt:

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 4 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022



LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
DFCC WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		RAJU SOLANKI DGM/CIVIL/SOUTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

TITLE : CONCEPTUAL PLAN AND LONGITUDINAL SECTION FROM CHAINAGE 10.0KM TO CHAINAGE 15.185KM (TUNNEL)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-10-15KM_A2

ISSUE DATE: 07.11.2022 REVISED DATE: 01.03.2023

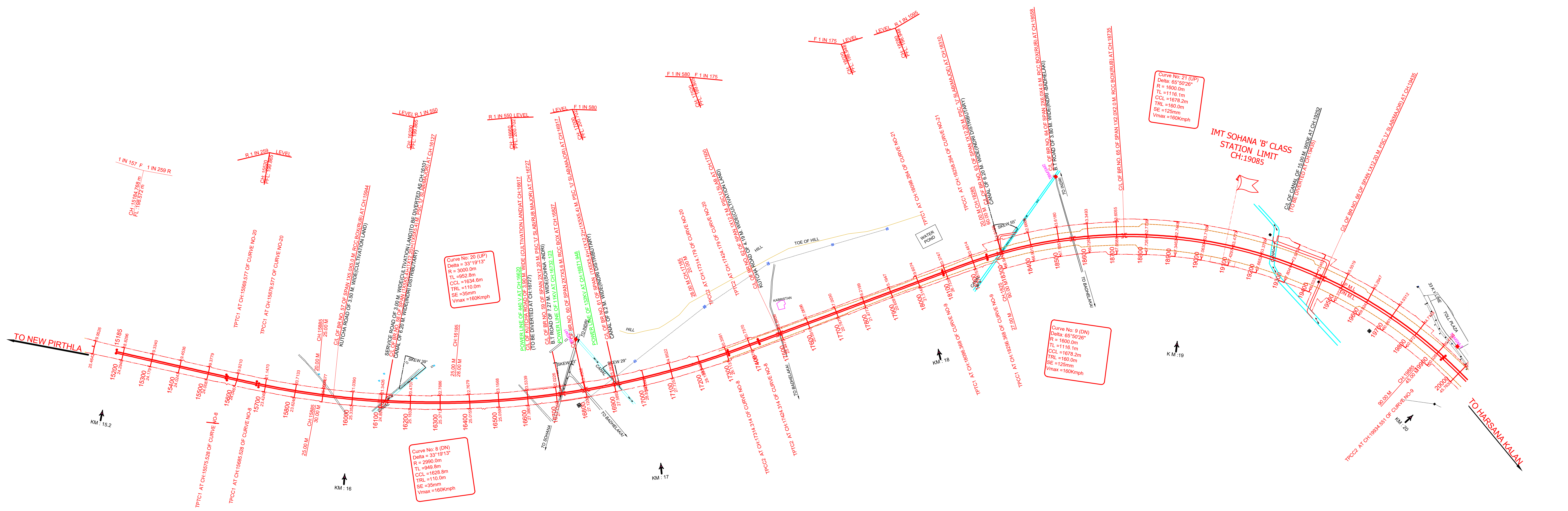
CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

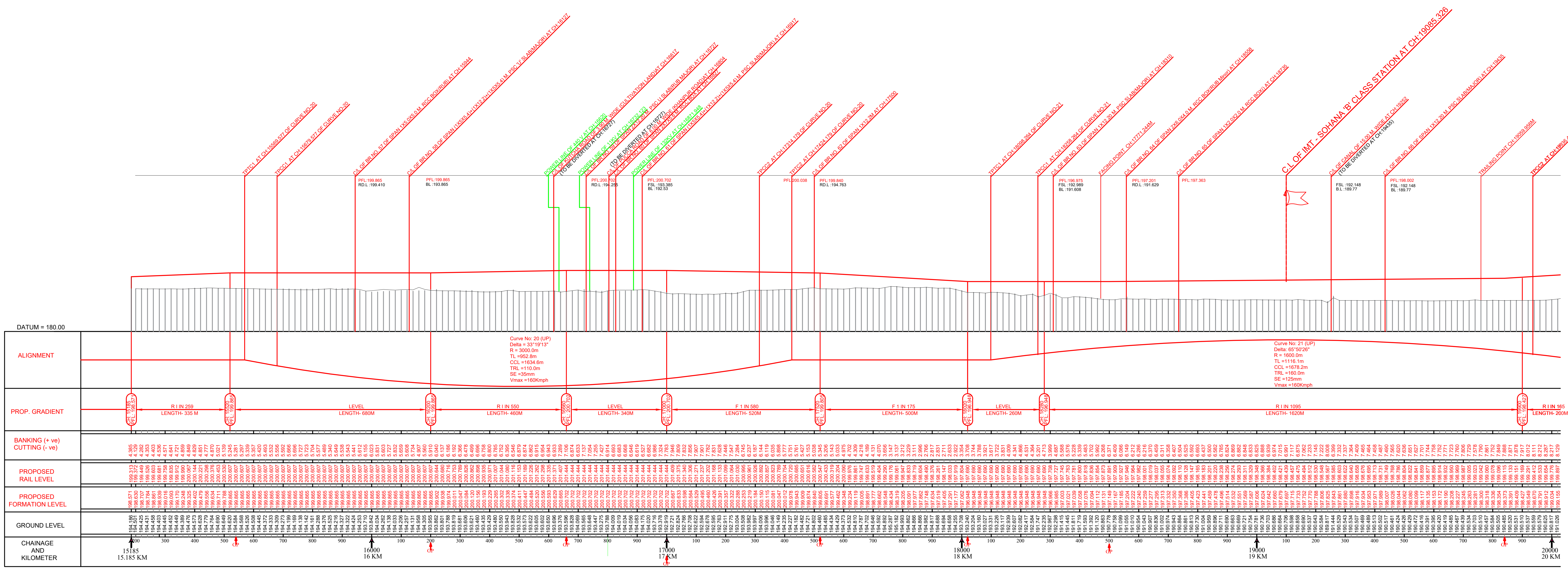
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 5 OF 24

SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022



PLAN



SECTION

NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANKING / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
11. TELEPHONE CABLE TO BE LAID FOR TELECOMMUNICATION.
12. ALL ELECTRICAL X-ING WILL BE AS PER PARA II (I) OF CHAPTER 1.GENERAL OF SCHEDULE 1 OF SOD 2004.

LIST OF TBM

TBM No.	Easting	Northing	Elevation
SM-1	705588.878	3121113.675	194.387
SM-2	704954.348	3119500.444	193.724
SM-3	703625.564	3118824.368	193.601

LEGEND

EXISTING CENTRE LINE	
PROPOSED CENTRE LINE	
DFC CENTRE LINE	
EXISTING TPTC	
PROPOSED TPTC	
TBM	
KM-STONE	
PROPOSED BOUNDARY	
EXISTING BRIDGE	
PROPOSED BRIDGE	
NALA,CANAL,DRAIN	
PERMANENT STRUCTURE	
TEMPORARY STRUCTURE	
PROPOSED GATE LODGE	
TOE LINE	
ROAD	
POWER LINE WITH POLE	
PYLON	
EMBANKMENT / BUND	
ROCKY AREA	
COMPOUND WALL	
DITCH / QUARRY	
BARBED WIRE FENCING	
GROUND LEVEL	

GC/HORC		HRIDC	
NAME /DESIGNATION	SIGN	NAME /DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		RAJU SOLANKI DGM/CIVIL/SOUTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

NORTHERN RAILWAY

DELHI DIVISION

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

SIGN

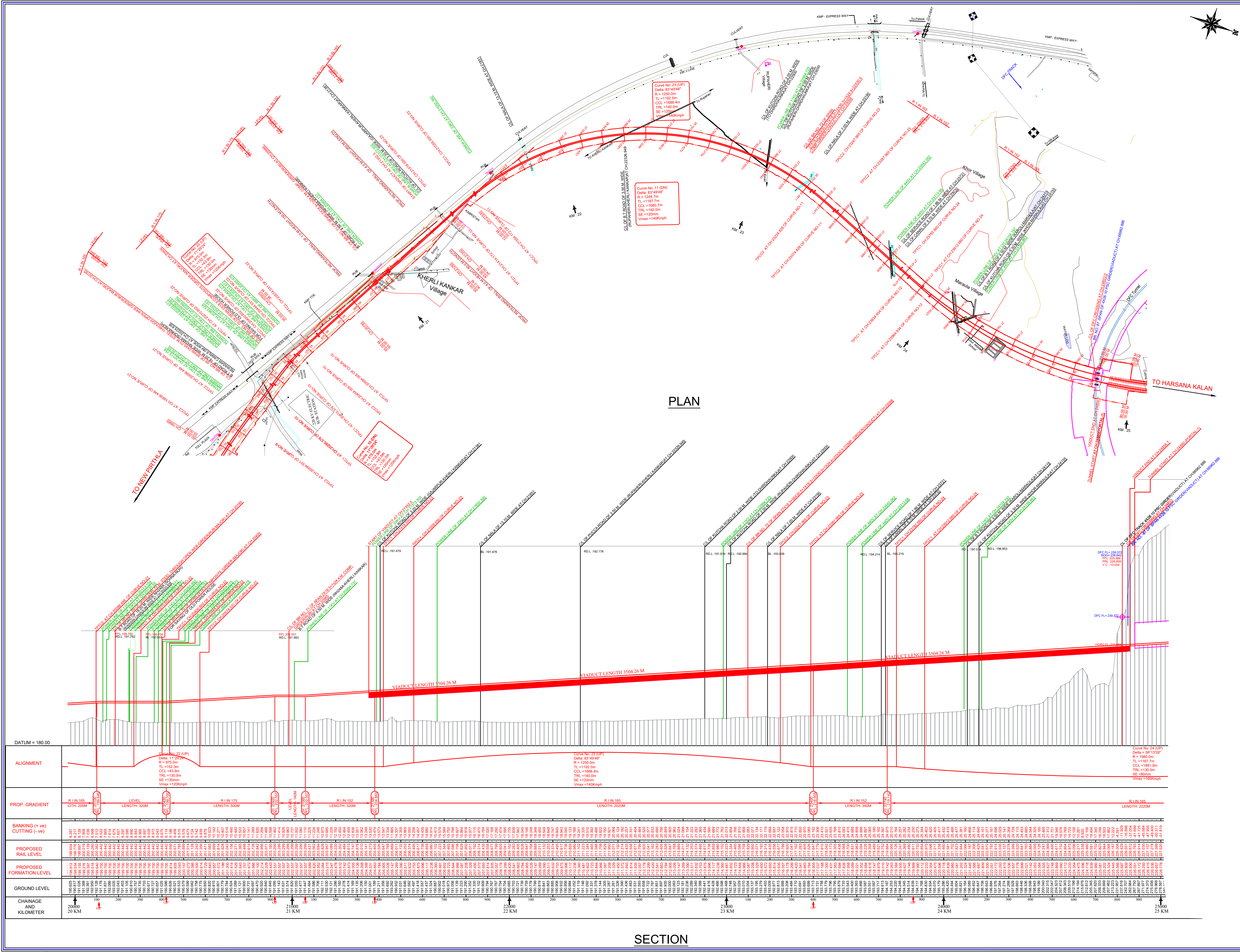
RITES THE INFRASTRUCTURE PEOPLE

SMEC

DRAWING NAME	CONCEPTUAL PLAN AND LONGITUDINAL SECTION FROM CHAINAGE 15.185KM TO CHAINAGE 20.0KM
GC/HORC DRG. NO:-	GC-HRIDC-ALL-DRW-ALN-P&P-15-20KM_A2
ISSUE DATE:	07.11.2022 REVISED DATE: 01.03.2023
SCALE	HORIZONTAL 1 :5000 VERTICAL 1:500
SMC DRG. NO:-	SMC/HRIDC/TUNNEL/LS- (R-4)
CONSULTANT:	S.M. CONSULTANTS An ISO 9001 Company Bhubaneswar / Balasore / Secunderabad / South Andaman / New Delhi Web : www.smcindia.com , E-Mail : support@smcindia.com
DRAWN BY:- L.MOHANTY	CHECKED BY:- SIVRAM J

A. A. SAMANT PROJECT INCHARGE

RELEASED FOR: PRELIMINARY FOR APPROVAL ☐ TENDER ☑ CONSTRUCTION ☐



NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANKING / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
11. TELEPHONE CABLE TO BE LAID FOR TELECOMMUNICATION.
12. ALL ELECTRICAL X-ING WILL BE AS PER PARA II (I) OF CHAPTER 1.GENERAL OF SCHEDULE 1 OF SOD 2004.

LIST OF TBM

TBM No.	Easting	Northing	Elevation
SM-1	705588.878	3121113.675	194.387
SM-2	704954.348	3119500.444	193.724
SM-3	703625.564	3118824.368	193.601

LEGEND

- EXISTING CENTRE LINE
- PROPOSED CENTRE LINE
- DFC CENTRE LINE
- EXISTING TPTC
- PROPOSED TPTC
- TBM
- KM-STONE
- PROPOSED BOUNDARY
- EXISTING BRIDGE
- PROPOSED BRIDGE
- NALA,CANAL,DRAIN
- PERMANENT STRUCTURE
- TEMPORARY STRUCTURE
- PROPOSED GATE LODGE
- TOE LINE
- ROAD
- POWER LINE WITH POLE
- PYLON
- EMBANKMENT / BUND
- ROCKY AREA
- COMPOUND WALL
- DITCH / QUARRY
- BARBED WIRE FENCING
- GROUND LEVEL

GC/HORC		HRIDC	
NAME /DESIGNATION	SIGN	NAME /DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		RAJU SOLANKI DGM/CIVIL/SOUTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

NORTHERN RAILWAY

DELHI DIVISION

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE

SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (20.0 KM TO 25.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-20-25KM_A0

ISSUE Dt: 25.02.2023 REVISED Dt:

SCALE HORIZONTAL 1 :5000 VERTICAL 1:500

SMC DRG. NO:- SMC/HRIDC/TUNNEL/LS- (R-4)

CONSULTANT: S.M. CONSULTANTS
An ISO 9001 Company
Bhubaneswar / Balasore / Secunderabad / South Andaman / New Delhi
Web : www.smcindia.com , E-Mail : support@smcindia.com

DRAWN BY:- L.MOHANTY CHECKED BY:- SIVRAM J

A. A. SAMANT
PROJECT INCHARGE

RELEASED FOR: PRELIMINARY FOR APPROVAL / TENDER ✓ / CONSTRUCTION

NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANKING / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. CRS. SANCTION WILL BE OBTAINED BEFORE EXECUTION OF WORK FALLING UNDER PARA 1302(2) OF IRPWM.
11. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
12. TELEPHONE CABLE TO BE LAID FOR TELECOMMUNICATION.
13. ALL ELECTRICAL X-ING WILL BE AS PER PARA II (I) OF CHAPTER 1.GENERAL OF SCHEDULE 1 OF SOD 2004.

LIST OF TBM

TBM No.	Easting	Northing	Elevation
SM-9	699327.653	3121920.632	253.2
SM-10	699041.016	3122185.520	271.558
SM-11	698349.641	3122451.730	284.291
SM-12	697601.855	3122685.020	278.11

LEGEND

- EXISTING CENTRE LINE
- PROPOSED CENTRE LINE
- DFC CENTRE LINE
- EXISTING TPTC
- PROPOSED TPTC
- TBM
- KM-STONE
- PROPOSED BOUNDARY
- EXISTING BRIDGE
- PROPOSED BRIDGE
- NALA,CANAL,DRAIN
- PERMANENT STRUCTURE
- TEMPORARY STRUCTURE
- PROPOSED GATE LODGE
- TOE LINE
- ROAD
- POWER LINE WITH POLE
- PYLON
- EMBANKMENT / BUND
- ROCKY AREA
- COMPOUND WALL
- DITCH / QUARRY
- BARBED WIRE FENCING
- GROUND LEVEL

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		RAJU SOLANKI DGM/CIVIL/SOUTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

NORTHERN RAILWAY

DELHI DIVISION

PROJECT:

HARYANA ORBITAL RAIL CORRIDOR

CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:

GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR

RITES Limited in consortium with SMEC International Pty. Ltd.

SIGN

RITES THE INFRASTRUCTURE PEOPLE

SMEC

GC/HORC DRG. NO:- GC-HRIDC-ALL-DRW-ALN-P&P-24-30KM_A0

DRAWING NAME: DETAILED PLAN AND LONGITUDINAL SECTION FROM CHAINAGE 24.0KM TO CHAINAGE 30.0KM (TUNNEL)

N.R.H.Q.E.(P) PLAN NO:

DIVISION PLAN NO :

SCALE: HORIZONTAL 1 :5000 VERTICAL 1:500

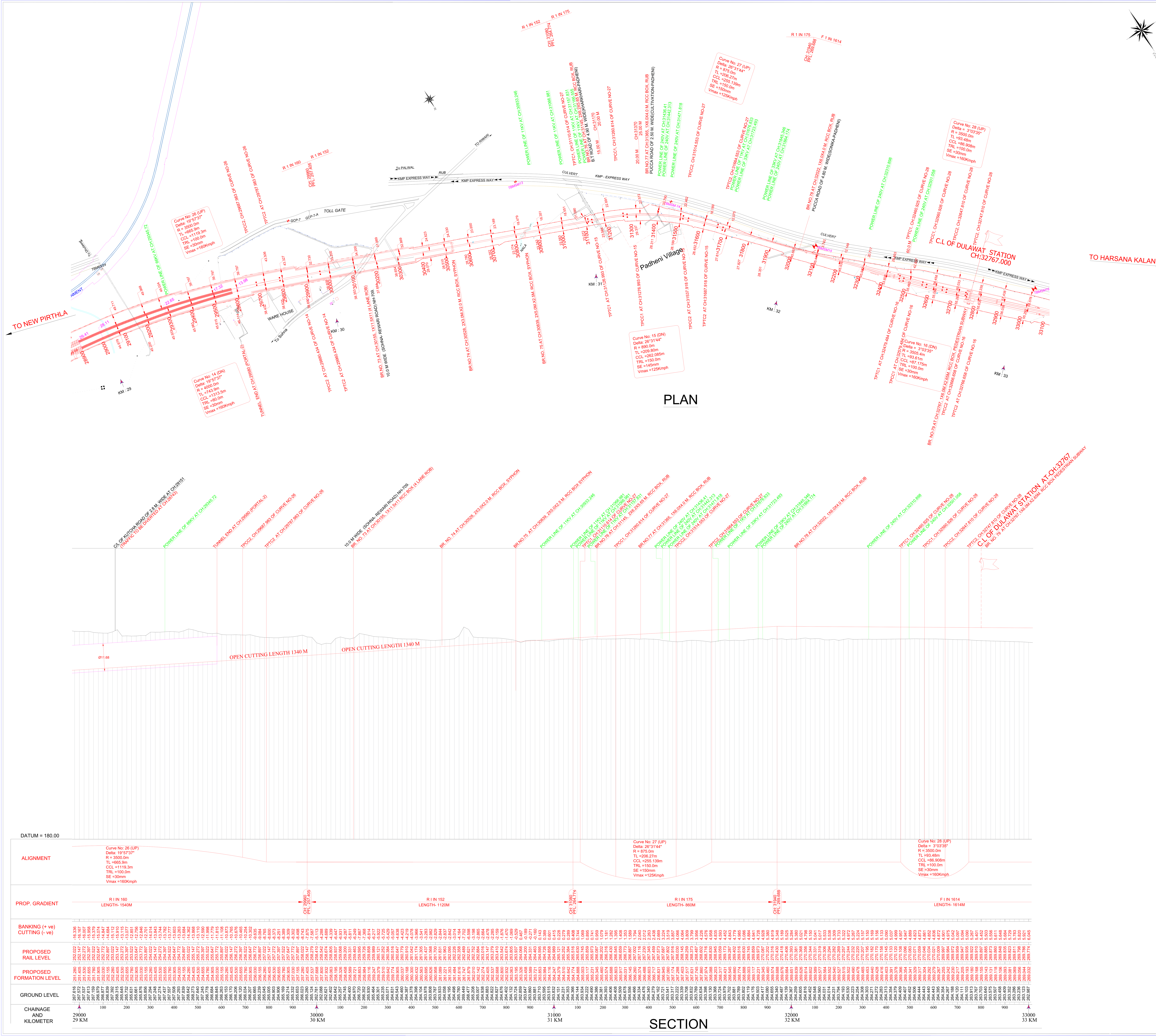
SMC DRG. NO:- SMC/HRIDC/TUNNEL/LS- (R-4)

CONSULTANT: S.M. CONSULTANTS
An ISO 9001 Company
Bhubaneswar / Balasore / Secunderabad / South Andaman / New Delhi
Web : www.smcindia.com , E-Mail : support@smcindia.com

DRAWN BY:- L.MOHANTY CHECKED BY:- SIVRAM J

A. A. SAMANT
PROJECT INCHARGE

RELEASED FOR: PRELIMINARY FOR APPROVAL ☐ TENDER ☑ CONSTRUCTION ☐



NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANKING / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
11. TELEPHONE CABLE TO BE LAID FOR TELECOMUNICATION.
12. ALL ELECTRICAL X-ING WILL BE AS PER PARA II (I) OF CHAPTER 1.GENERAL OF SCHEDULE 1 OF SOD 2004.

LEGEND

- EXISTING CENTRE LINE
- PROPOSED CENTRE LINE
- DFC CENTRE LINE
- EXISTING TPTC
- PROPOSED TPTC
- TBM
- KM-STONE
- PROPOSED BOUNDARY
- EXISTING BRIDGE
- PROPOSED BRIDGE
- NALA,CANAL,DRAIN
- PERMANENT STRUCTURE
- TEMPORARY STRUCTURE
- PROPOSED GATE LODGE
- TOE LINE
- ROAD
- POWER LINE WITH POLE
- PYLON
- EMBANKMENT / BUND
- ROCKY AREA
- COMPOUND WALL
- DITCH / QUARRY
- BARBED WIRE FENCING
- GROUND LEVEL

GC/HORC

NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC

NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
RAJU SOLANKI DGM/CIVIL	

NORTHERN RAILWAY

DELHI DIVISION

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

SIGN

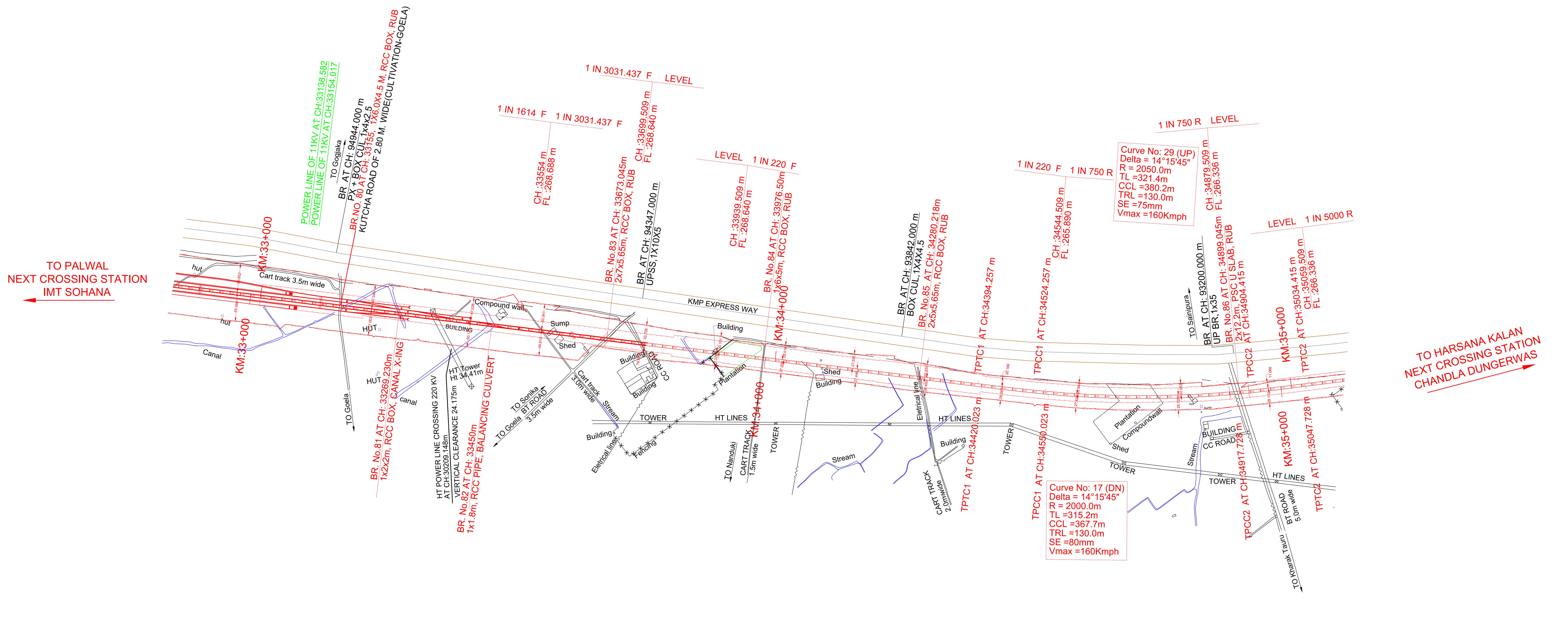
RITES THE INFRASTRUCTURE PEOPLE

SMEC

TITLE:	CONCEPTUAL PLAN & LONGITUDINAL SECTION (29 KM TO 33.0 KM)
GC/HORC DRG. NO:-	GC-HRIDC-ALL-DRW-ALN-P&P-29-33KM_A1
ISSUE Dt:	11.11.2022 REVISED Dt: 24.12.2022
SCALE	HORIZONTAL 1 :5000 VERTICAL 1:500
SMC DRG. NO:-	SMC/HRIDC/TUNNEL/LS- (R-4)
CONSULTANT:	S.M. CONSULTANTS An ISO 9001 Company Bhubaneswar / Balasore / Secunderabad / South Andaman / New Delhi Web : www.smcindia.com , E-Mail : support@smcindia.com
DRAWN BY:-	L.MOHANTY
CHECKED BY:-	SIVRAM J

A. A. SAMANT
PROJECT INCHARGE

RELEASED FOR: PRELIMINARY FOR APPROVAL / ☑ TENDER / CONSTRUCTION



LEGEND:	
EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

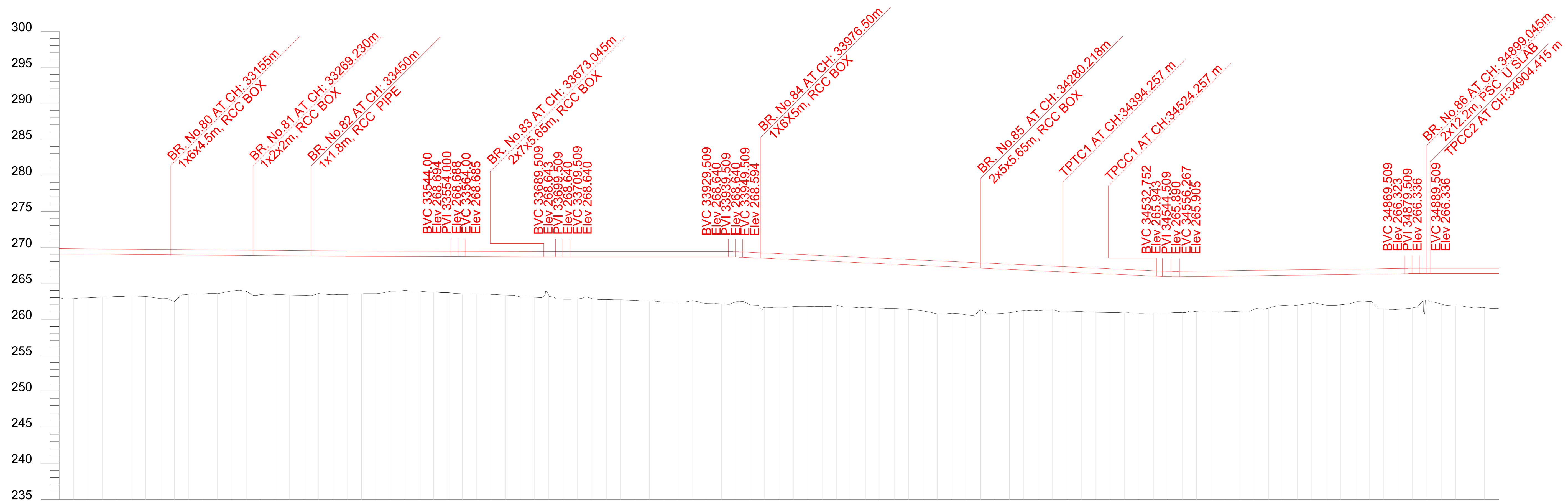
NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CENTRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :	
PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	



HORIZONTAL ALIGNMENT: L=1646.447m; TRL=130m; R =2050m; TRL=130m

VERTICAL ALIGNMENT: L=1594m, 1 IN 1614 F; L=20.000m, R=21220.654m; L=125.509m, 1 IN 3031.437 F; L=20.000m, R=-60000.00m; L=220.000m, LEVEL; L=20.000m, R=4400.04m; L=583.243m, 1 IN 220 F; L=23.515m, R=-4000.02m; L=313.242m, 1 IN 750 R; L=20.000m, R=15000.01m; L=160.000m, LEVEL

CHAINAGES	GROUND LEVELS	PROPOSED FORMATION LEVEL	PROPOSED RAIL LEVEL	DEPTH OF CUTTING (-) HIGHT OF BANKING (+)
33000.0	262.987	269.032	269.774	+6.045
33020.0	262.854	269.019	269.761	+6.165
33040.0	262.977	269.007	269.749	+6.030
33060.0	263.065	268.994	269.736	+5.929
33080.0	263.157	268.982	269.724	+5.825
33100.0	263.242	268.970	269.712	+5.728
33120.0	263.168	268.957	269.699	+5.789
33140.0	262.861	268.945	269.687	+6.084
33160.0	262.470	268.932	269.674	+6.462
33180.0	263.458	268.920	269.662	+5.462
33200.0	263.527	268.908	269.650	+5.381
33220.0	263.551	268.895	269.637	+5.344
33240.0	263.915	268.883	269.625	+4.968
33260.0	263.860	268.870	269.612	+5.010
33280.0	263.445	268.858	269.600	+5.413
33300.0	263.415	268.846	269.588	+5.431
33320.0	263.357	268.833	269.575	+5.476
33340.0	263.305	268.821	269.563	+5.516
33360.0	263.550	268.808	269.550	+5.258
33380.0	263.402	268.796	269.538	+5.394
33400.0	263.446	268.784	269.526	+5.338
33420.0	263.524	268.771	269.513	+5.247
33440.0	263.536	268.759	269.501	+5.223
33460.0	263.872	268.747	269.489	+4.875
33480.0	263.998	268.734	269.476	+4.736
33500.0	263.897	268.722	269.464	+4.825
33520.0	263.799	268.709	269.451	+4.910
33540.0	263.703	268.697	269.439	+4.994
33560.0	263.528	268.686	269.428	+5.158
33580.0	263.479	268.679	269.421	+5.200
33600.0	263.450	268.673	269.415	+5.223
33620.0	263.354	268.666	269.408	+5.312
33640.0	263.101	268.659	269.401	+5.558
33660.0	263.048	268.653	269.395	+5.605
33680.0	263.350	268.646	269.388	+5.296
33700.0	262.769	268.640	269.382	+5.871
33720.0	262.825	268.640	269.382	+5.815
33740.0	262.859	268.640	269.382	+5.781
33760.0	262.743	268.640	269.382	+5.897
33780.0	262.700	268.640	269.382	+5.940
33800.0	262.598	268.640	269.382	+6.042
33820.0	262.532	268.640	269.382	+6.108
33840.0	262.408	268.640	269.382	+6.232
33860.0	262.371	268.640	269.382	+6.269
33880.0	262.580	268.640	269.382	+6.060
33900.0	262.180	268.640	269.382	+6.460
33920.0	262.136	268.640	269.382	+6.504
33940.0	262.372	268.627	269.369	+6.255
33960.0	261.999	268.546	269.288	+6.547
33980.0	261.639	268.456	269.198	+6.817
34000.0	261.657	268.365	269.107	+6.708
34020.0	261.756	268.274	269.016	+6.518
34040.0	261.764	268.183	268.925	+6.419
34060.0	261.762	268.092	268.834	+6.330
34080.0	261.886	268.001	268.743	+6.115
34100.0	261.686	267.910	268.652	+6.224
34120.0	261.650	267.819	268.561	+6.169
34140.0	261.544	267.728	268.470	+6.184
34160.0	261.492	267.637	268.379	+6.145
34180.0	261.357	267.546	268.288	+6.189
34200.0	261.144	267.456	268.198	+6.312
34220.0	260.735	267.365	268.107	+6.630
34240.0	260.841	267.274	268.016	+6.433
34260.0	260.609	267.183	267.925	+6.574
34280.0	261.289	267.092	267.834	+5.803
34300.0	260.758	267.001	267.743	+6.243
34320.0	260.901	266.910	267.652	+6.009
34340.0	261.171	266.819	267.561	+5.648
34360.0	261.169	266.728	267.470	+5.559
34380.0	261.300	266.637	267.379	+5.337
34400.0	261.020	266.546	267.288	+5.526
34420.0	261.061	266.456	267.198	+5.395
34440.0	260.974	266.365	267.107	+5.391
34460.0	260.913	266.274	267.016	+5.361
34480.0	260.887	266.183	266.925	+5.296
34500.0	260.838	266.092	266.834	+5.254
34520.0	260.881	266.001	266.743	+5.120
34540.0	260.865	265.917	266.659	+5.052
34560.0	260.911	265.910	266.652	+4.999
34580.0	261.049	265.937	266.679	+4.888
34600.0	260.998	265.964	266.706	+4.966
34620.0	261.043	265.990	266.732	+4.947
34640.0	261.037	266.017	266.759	+4.980
34660.0	261.373	266.044	266.786	+4.671
34680.0	261.549	266.070	266.812	+4.521
34700.0	261.906	266.097	266.839	+4.191
34720.0	261.952	266.124	266.866	+4.172
34740.0	262.242	266.150	266.892	+3.908
34760.0	261.953	266.177	266.919	+4.224
34780.0	262.009	266.204	266.946	+4.195
34800.0	262.358	266.230	266.972	+3.872
34820.0	262.461	266.257	266.999	+3.796
34840.0	261.397	266.284	267.026	+4.887
34860.0	261.372	266.310	267.052	+4.938
34880.0	261.579	266.333	267.075	+4.754
34900.0	262.547	266.336	267.078	+3.789
34920.0	262.109	266.336	267.078	+4.227
34940.0	261.865	266.336	267.078	+4.471
34960.0	261.638	266.336	267.078	+4.698
34980.0	261.597	266.336	267.078	+4.739
35000.0	261.528	266.336	267.078	+4.808

LONGITUDINAL PROFILE
HORIZONTAL-1:5000, VERTICAL-1:500

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC	
NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
RAJU SOLANKI DGM/CIVIL	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (33.0 KM TO 35.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-33-35KM_A1

ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

CONSULTANTS : AARVEE ASSOCIATES

aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633, Fax: 91-40-23736277
e-mail: railways@aarvee.net, web:www.aarvee.net

TANMAY (AM CAD) DRAWN | G.PRASAD (M) CHECKED | N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 6 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC

NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	Chahatey Ram
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC

NAME / DESIGNATION	SIGN
R. R. KUMAR *GM/ IP&P*	
RAJU SOLANKI *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (35.0 KM TO 40.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-35-40KM_A1

ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

Tanmay Dash		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 7 OF 24

SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC

NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC

NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
UMA. M. RAO DGM/CIVIL	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (40.0 KM TO 45.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-40-45KM_A1

ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

CONSULTANTS : aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 8 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC

NAME / DESIGNATION	SIGN
CHAHATEY RAM *PD*	Chahatey Ram
SUDHIR AGRAWAL *DPD/CIVIL*	
KRISHAN CHAND SAINSI *CRE/CIVIL*	

HRIDC

NAME / DESIGNATION	SIGN
R. R. KUMAR *GM/ IP&P*	
UMA. M. RAO *DGM/CIVIL*	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION (45.0 KM TO 50.0 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-45-50KM_A1

ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

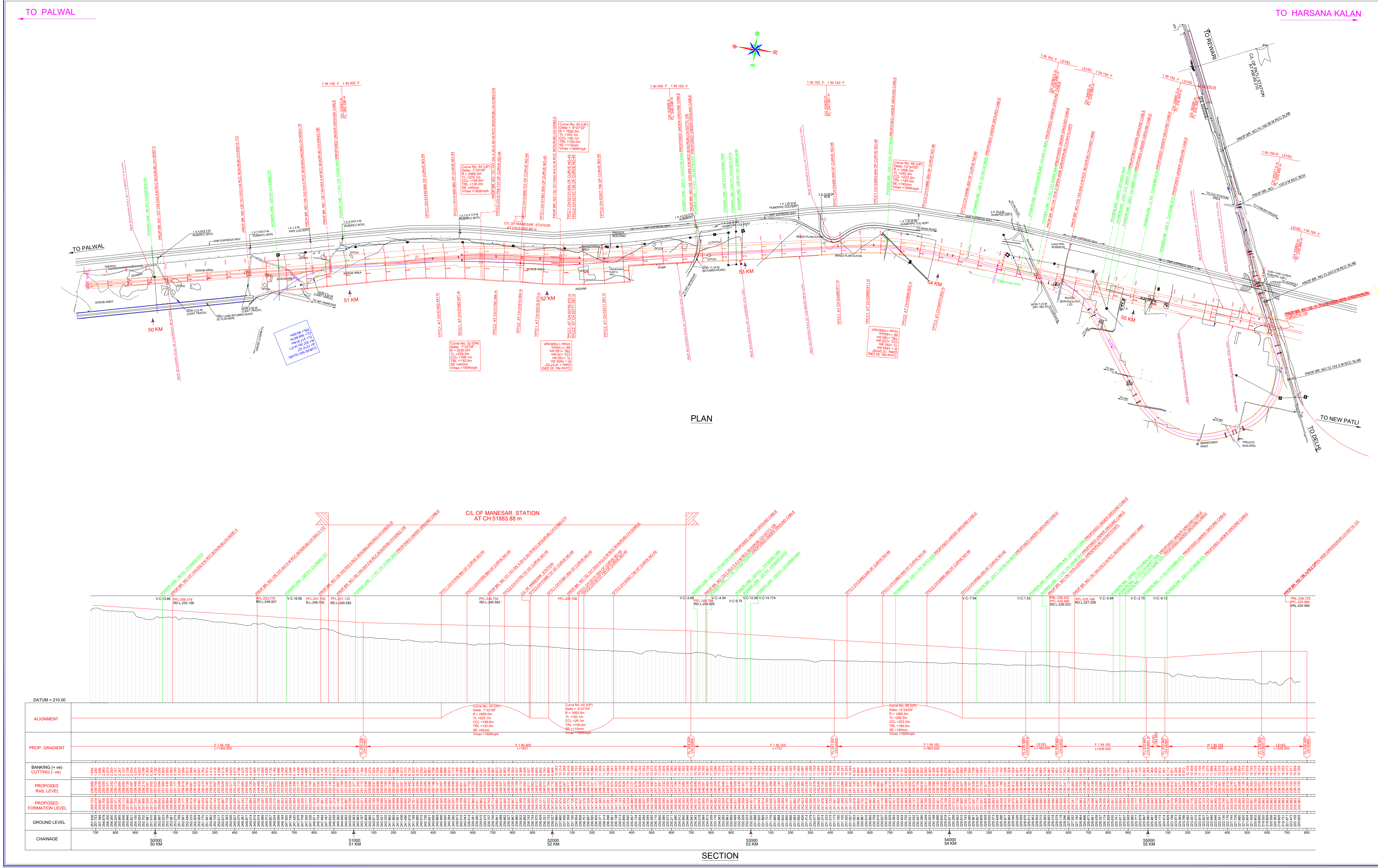
CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/R3 | SHEET No. 9 OF 24

SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022



NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANK / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. CRS. SANCTION WILL BE OBTAINED BEFORE EXECUTION OF WORK FALLING UNDER PARA 1302(2) OF IRPWM.
11. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
12. TELEPHONE CABLE TO BE LAID FOR TELECOMUNICATION.

RETAINING WALL

MAIN LINE

LHS				RHS			
From Ch:	To Ch:	height Of Retaining Wall (m)	Length (m)	From Ch:	To Ch:	height Of Retaining Wall (m)	Length (m)
50048	50063	1.5	15	49892	50292	1	400
53453	53503	1.5	50	51842	51942	5	100
55292	55492	1.5	200	52610	52730	1	120
55492	55662	3	170	52972	53014	1	42
Total Length			435	53132	53392	1	260
				55242	55492	1.5	250
				55492	55662	3	170
				Total Length			1342

LEGEND

- EXISTING CENTRE LINE
- PROPOSED WORK
- DISMENTAL WORK
- EXISTING TPTC
- PROPOSED TPTC
- TBM
- KM-STONE
- RAILWAY BOUNDARY
- EXISTING BRIDGE
- PROPOSED BRIDGE
- NALA,CANAL,DRAIN
- PERMANENT STRUCTURE
- TEMPORARY STRUCTURE
- PROPOSED GATE LODGE
- LAND ACQUISITION
- ROAD
- POWER LINE WITH POLE
- PYLON
- EMBANKMENT / BUND
- ROCKY AREA
- COMPOUND WALL
- DITCH / QUARRY
- BARBED WIRE FENCING
- GROUND LEVEL
- RETAINING WALL

GC/HORC	SIGNATURE

HRIDC	SIGNATURE

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION

PROJECT: HARYANA ORBITAL RAIL CORRIDOR

STANDARD: GAUGE 1676 mm. LENGTH :6 KM
YEAR OF SURVEY- - - - - - - - - - - - - - - 2020
STANDARD OF CONSTUCTION - - - - - - - - - - - GROUP-A

DRAWING: DETAILED PLAN AND LONGITUDINAL SECTION FROM CHAINAGE 49683.217 TO CHAINAGE 55784.097 (MAIN LINE)

SCALE: HORIZONTAL 1 :5000 (50 25 0 50 100 150.METRES) VERTICAL 1:500 (5 2.5 0 5 10 15 METRES)

CONSULTANT:- DRAWING NO : HRIDC/PS/ LS -1

S.M. CONSULTANTS
An ISO 9001 Company
Bhubaneswar / Delhi / Balasore / Secunderabad / South Andaman
Web : www.smcindia.com , E-Mail : support@smcindia.com

A A SAMANT
PROJECT INCHARGE

DRAWN	ITISHREE	CHECKED	SIVRAM J	13-07-2021	1	1
				DATE	SHEET NO.	REVISION

RELEASED FOR: ☐ PRELIMINARY FOR APPROVAL ☑ TENDER ☐ CONSTRUCTION

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC	
NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
UMA. M. RAO DGM/CIVIL	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION
(55.0 KM TO 61.5 KM)

GC DRG.NO. GC-HRIDC-ALL-DRW-ALN-P&P-55-61.5KM_A1

ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
Tanmay Dash		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/2245/AL/DR/P&P/55-60/R3 | SHEET No. 1
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA RAO DGM/C/WEST	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(60.0km TO 65.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 11 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(65.0km TO 70.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 12 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(70.0km TO 75.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 13 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LONGITUDINAL PROFILE

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CENTRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(75.0km TO 80.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 14 OF 24
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019 REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(80.0km TO 85.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 15 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC Member of the Surbana Jurong Group

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(85.0km TO 90.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 16 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- TRACK = 60KG RAILS
- SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- BALLAST CUSHION : 350mm
- ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :
- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(90.0km TO 95.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 17 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC DRG.NO.

TITLE :

PLAN & LONGITUDINAL SECTION
(95.0km TO 100.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 18 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(100.0km TO 105.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 19 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(105.0km TO 110.0km)

CONSULTANTS : AARVEE ASSOCIATES

aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 20 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(110.0km TO 115.0km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 21 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(115.0km TO 120.0km)

CONSULTANTS : AARVEE ASSOCIATES
aarvee associates architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

DRAWN	CHECKED	APPROVED
TANMAY (AM CAD)	G.PRASAD (M)	N.J. RAO (VP)

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 22 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022

LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	
EXPRESSWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

PROPOSED RAIL PROFILE
PROPOSED FORMATION PROFILE
GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

GC DRG.NO.

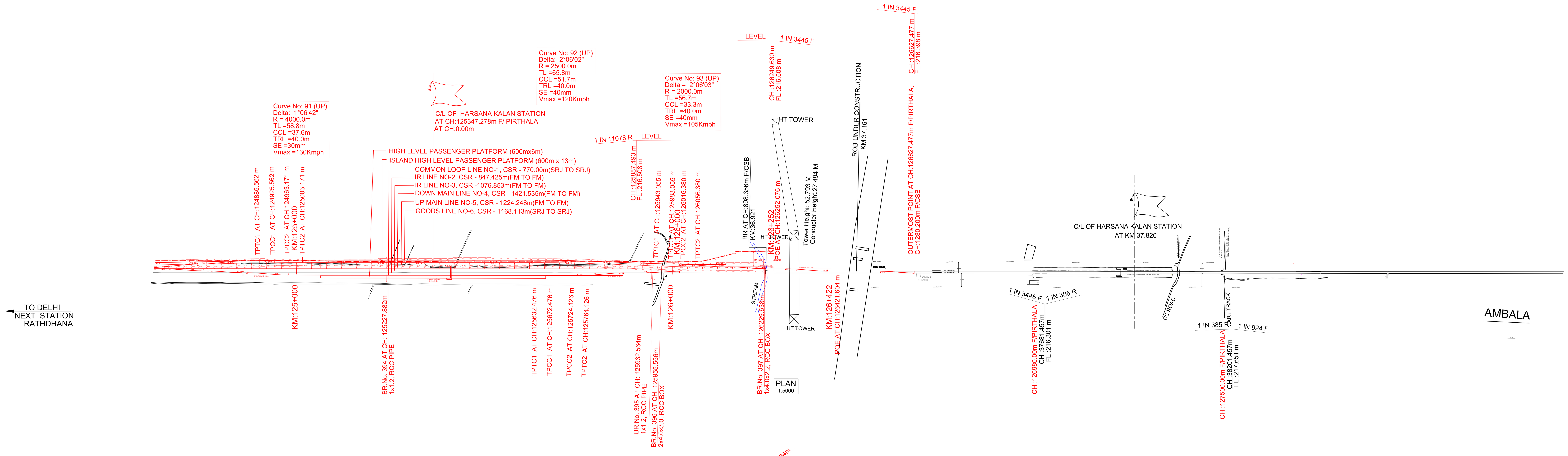
TITLE :
PLAN & LONGITUDINAL SECTION
(120.0km TO 125.0km)

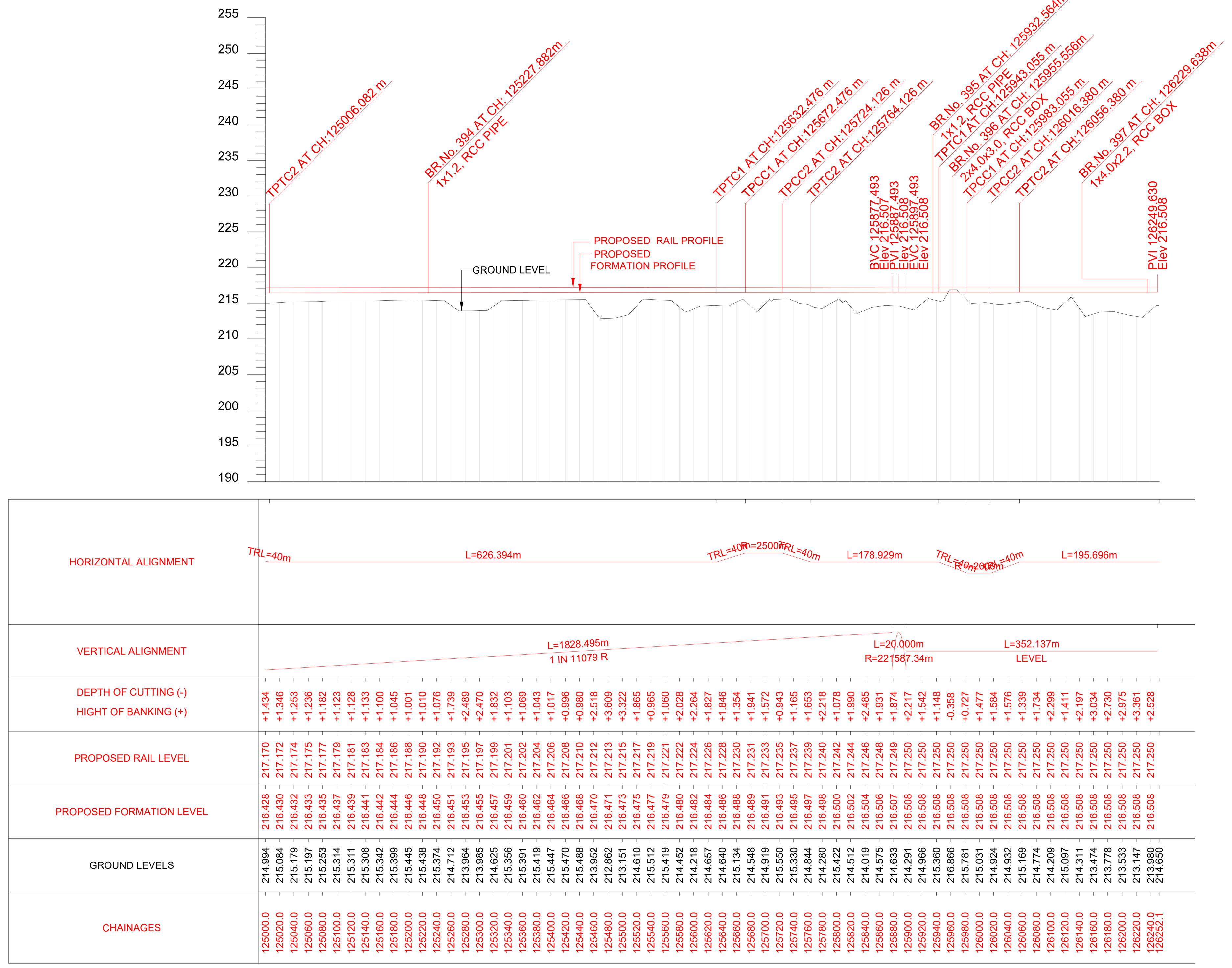
CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

DRAWN	CHECKED	APPROVED
TANMAY (AM CAD)	G.PRASAD (M)	N.J. RAO (VP)

DRG.NO. AA/2245/AL/DR/P&P/R3 | SHEET No. 23 OF 24
SCALE : H = 1:5000 V = 1:500 | ISSUED Dt: 26.11.2019 | REV Dt: 06-08-2022





LONGITUDINAL PROFILE

HORIZONTAL:1:5000, VERTICAL:1:500

LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND
- PRO.TOE LINE

NOTE:-

1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed

- * TRACK = 60KG RAILS
- * SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
- * BALLAST CUSHION : 350mm
- * ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

- PROPOSED RAIL PROFILE
- PROPOSED FORMATION PROFILE
- GROUND PROFILE

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR
HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

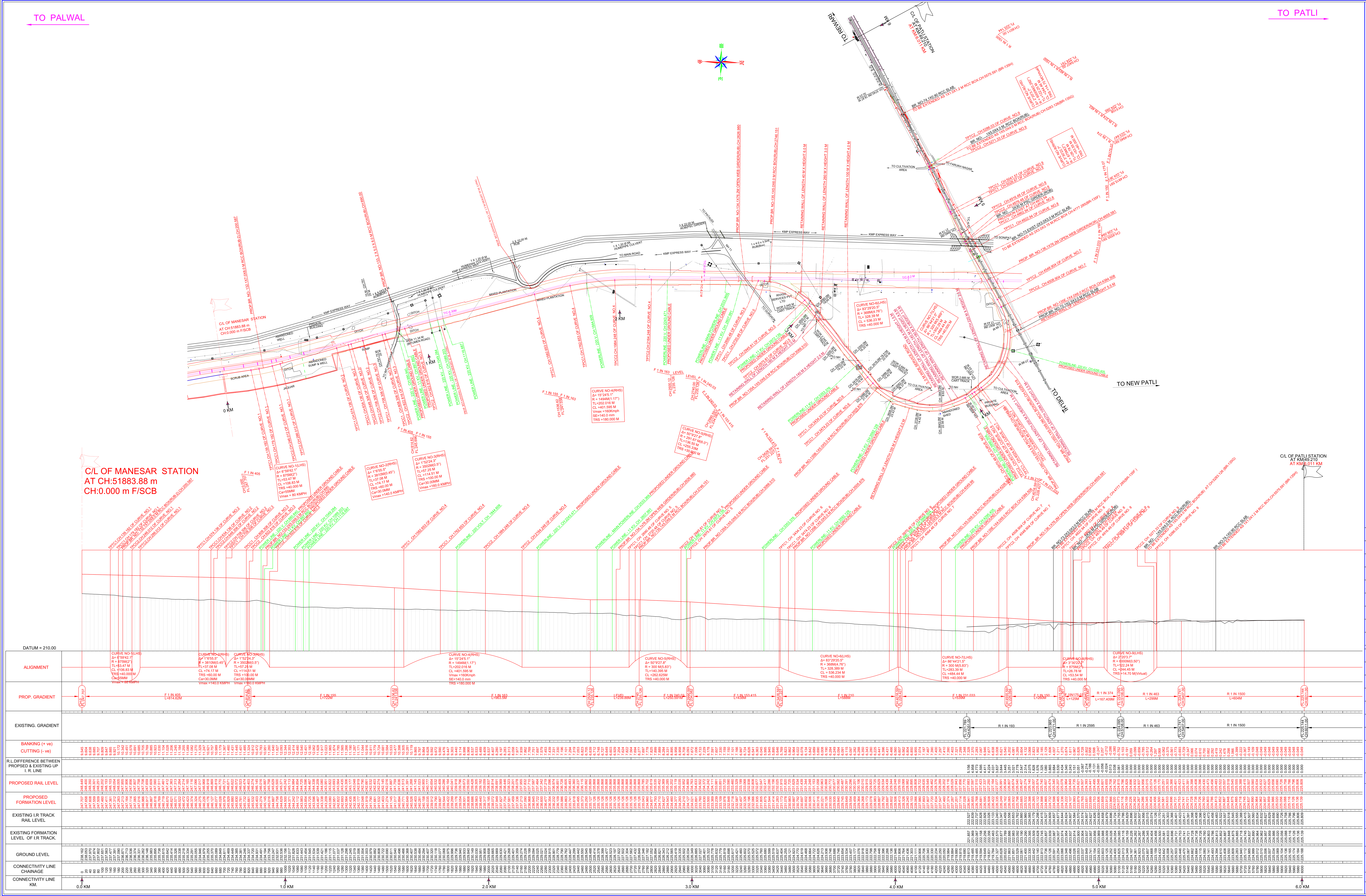
GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
(125.0km TO 126.252km)

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No. 24 OF 24	
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022



NOTES :-

1. EXISTING WORK SHOWN IN BLACK.
2. PROPOSED WORK SHOWN IN RED.
3. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
4, CHAINAGE IS RECKONED 0.00 FROM C.L. OF NEW PRITHLA STATION BUILDING .
5. RAIL LEVEL SHOULD BE 0.742m ABOVE FORMATION LEVEL FOR TRACK STRUCTURE 60KG NEW RAIL ON PSC SLEEPER (1660/KM) WITH 350mm BALLAST CUSHION.
6. RULLING GRADIENT IS 1 IN 150 OF THIS SECTION.(COMPENSATED)
7. VERTICAL CURVE WILL BE PROVIDED AS PER IRPWM PARA 419.
8. CROSS / LONGITUDINAL DRAINAGE ARRANGEMENT BET.TRACK SHOULD BE PROVIDED WHEREVER REQUIRED .
9. TROLLY REFUDGE IN BANK / CUTTING SHALL BE PROVIDED AS PER PROVISION OF IRPWM.
10. CRS. SANCTION WILL BE OBTAINED BEFORE EXECUTION OF WORK FALLING UNDER PARA 1302(2) OF IRPWM.
11. STANRDARD OF LOADING (FOR PROP. LINE):- 32.5 T LOADING-2008 & HIGH RISE OHE.
12. TELEPHONE CABLE TO BE LAID FOR TELECOMUNICATION.

LEGEND	
EXISTING CENTRE LINE	
PROPOSED CENTRE LINE	
EXISTING TPTC	
PROPOSED TPTC	
TBM	
KM-STONE	
RAILWAY BOUNDARY	
EXISTING BRIDGE	
PROPOSED BRIDGE	
NALA,CANAL,DRAIN	
PERMANENT STRUCTURE	
TEMPORARY STRUCTURE	
PROPOSED GATE LODGE	
LAND ACQUISITION	
ROAD	
POWER LINE WITH POLE	
PYLON	
EMBANKMENT / BUND	
ROCKY AREA	
COMPOUND WALL	
DITCH / QUARRY	
BARBED WIRE FENCING	
GROUND LEVEL	

NORTHERN RAILWAY	
DRM-DLI	
ADRM-INFRA-DLI	
SRDEN-CO-DLI	
SRDOM- DLI	
SRDSTE-DLI	
SRDEE-TRD-DLI	
SRDEN-5-DLI	
ADEN-DEE	
SSE-PWAY-GGN	
SSE-W-GGN	

HRIDC	SIGNATURE

GC/HORC	SIGNATURE

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION

PROJECT	HARYANA ORBITAL RAIL CORRIDOR
STANDARD	GAUGE 1676 mm. LENGTH :6 KM YEAR OF SURVEY - 2020 STANDARD OF CONSTUCTION - GROUP-A
DRAWING	DETAILED PLAN AND LONGITUDINAL SECTION FROM CHAINAGE 0 TO CHAINAGE 5720 M (CONNECTIVITY LINE)
SCALE	HORIZONTAL 1 :5000 (50 25 0 50 100 150.METRES) VERTICAL 1:500 (5 2.5 0 5 10 15 METRES)

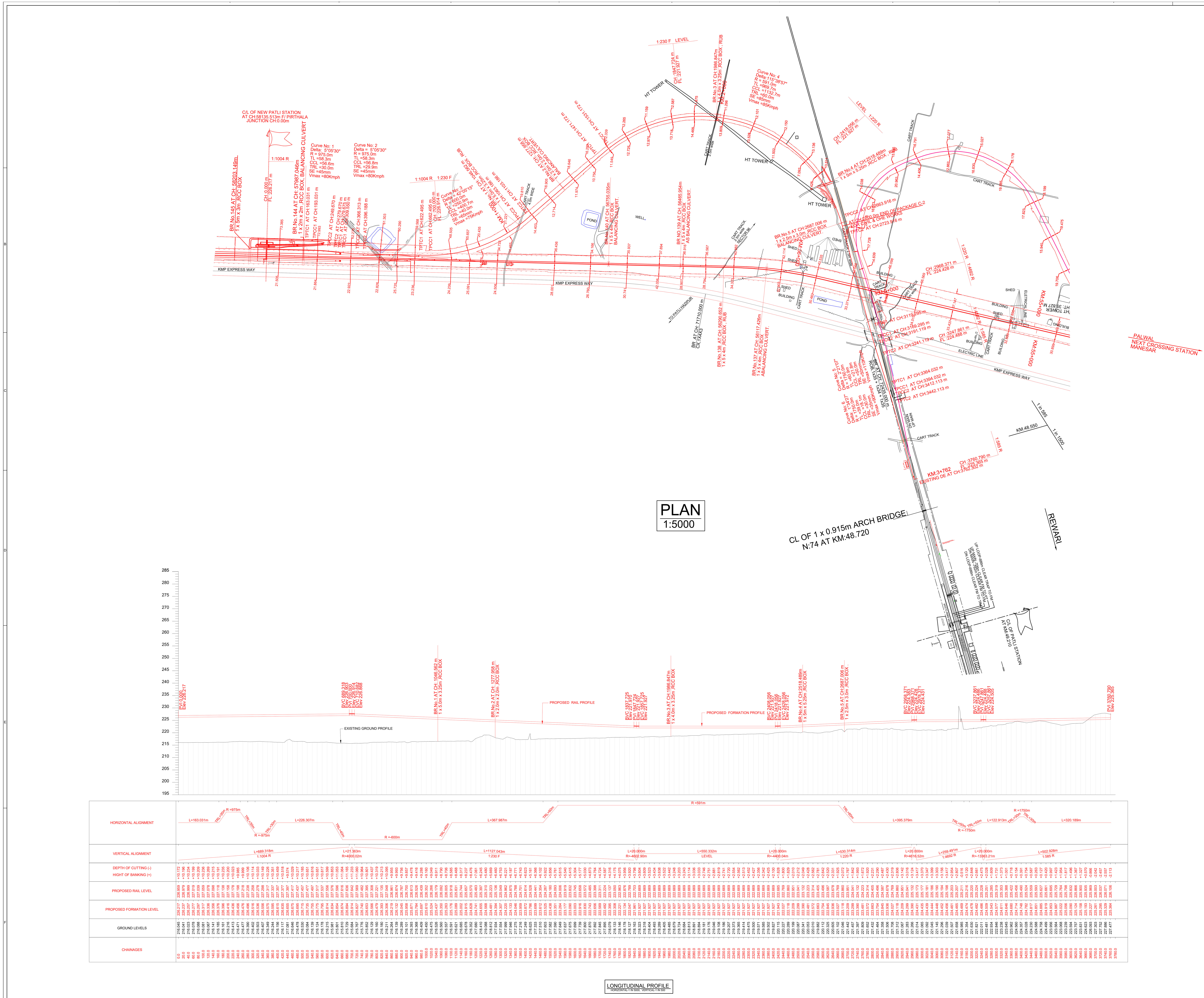
CONSULTANT:- DRAWING NO : HRIDC/PS/ LS -2

S.M. CONSULTANTS
An ISO 9001 Company
Bhubaneswar / Delhi / Balasore / Secunderabad / South Andaman
Web : www.smcindia.com , E-Mail : support@smcindia.com

A A SAMANT
PROJECT INCHARGE

DRAWN	ITISHREE	CHECKED	SIVRAM J	DATE	SHEET NO.	REVISION
				13-07-2021	1	1

RELEASED FOR: PRELIMINARY FOR APPROVAL ☐ TENDER ☑ CONSTRUCTION ☐



LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- KMP EXPRESSWAY
- KMP EXPRESSWAY BOUNDARY
- EXISTING RAILWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND

NOTE:-

1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED
2. .CH:0.00 FOR CONNECTIVITY LINE IS RECKONED FROM NEW PATLI STATION
3. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
4. TRACK CENTER BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-

1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

GC/HORC

NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC

NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
UMA. M. RAO DGM/CIVIL	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION CONNECTIVITY TOWARDS PATLI

GC DRG.NO. GC-HRIDC-C2-DRW-ALN-P&P-03001_A2

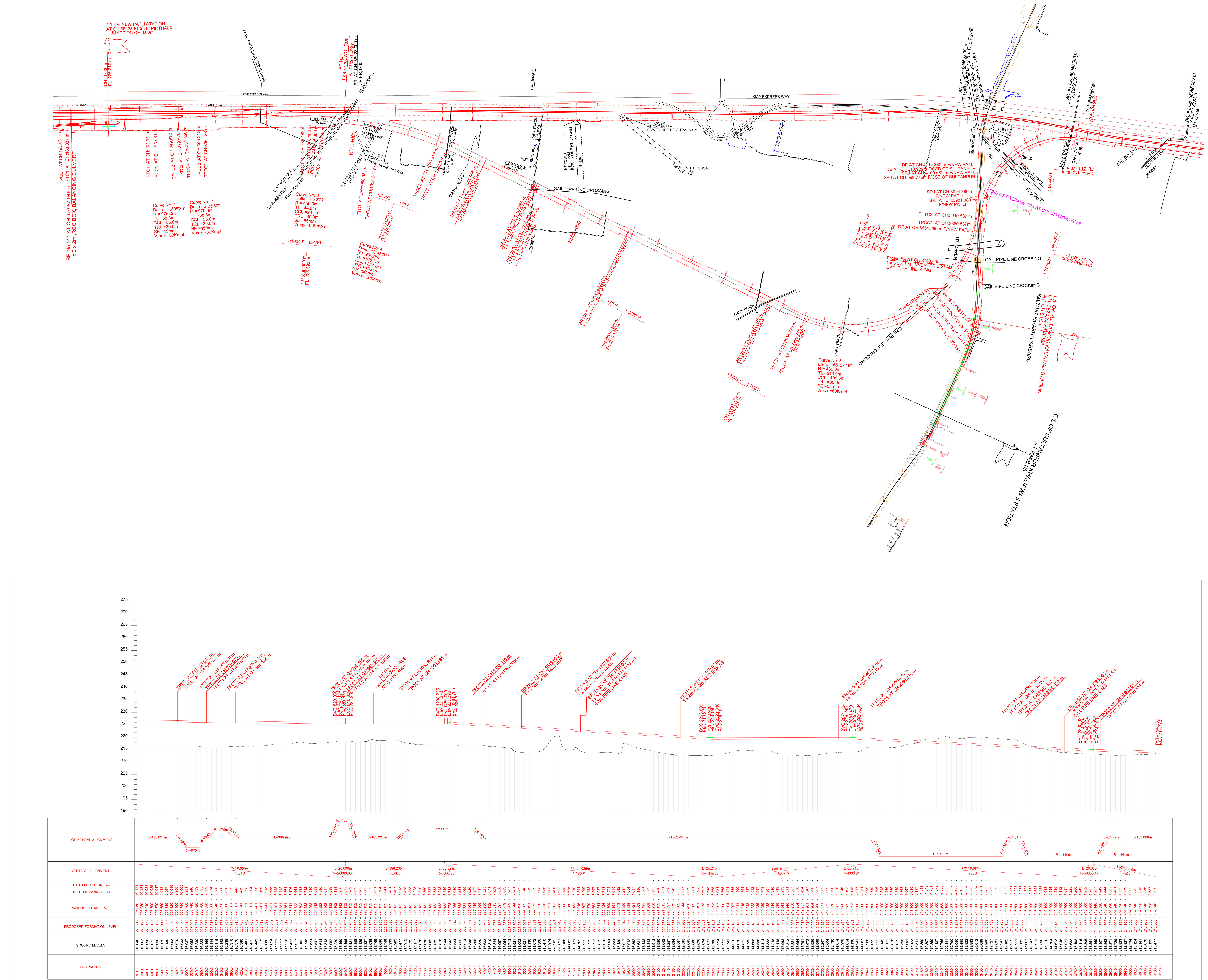
ISSUE Dt: 11.11.2022 | REVISED Dt: 24.12.2022

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/REV-2	SHEET No. 1	
SCALE : 1:1000	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022



LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	PROW PROW
KMP EXPRESSWAY	
KMP EXPRESSWAY BOUNDARY	PROW PROW
EXISTING RAILWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	

NOTE:-
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE STATED
2. .CH:0.00 FOR CONNECTIVITY LINE IS RECKONED FROM NEW PATLI STATION
3. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
4. TRACK CENTER BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :

EXISTING RAIL PROFILE	
PROPOSED FORMATION PROFILE	
GROUND PROFILE	

GC/HORC	
NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram
SUDHIR AGRAWAL DPD/CIVIL	
KRISHAN CHAND SAINSI CRE/CIVIL	

HRIDC	
NAME / DESIGNATION	SIGN
R. R. KUMAR GM/ IP&P	
UMA. M. RAO DGM/CIVIL	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE
SMEC

TITLE : CONCEPTUAL PLAN & LONGITUDINAL SECTION CONNECTIVITY TOWARDS SULTANPUR

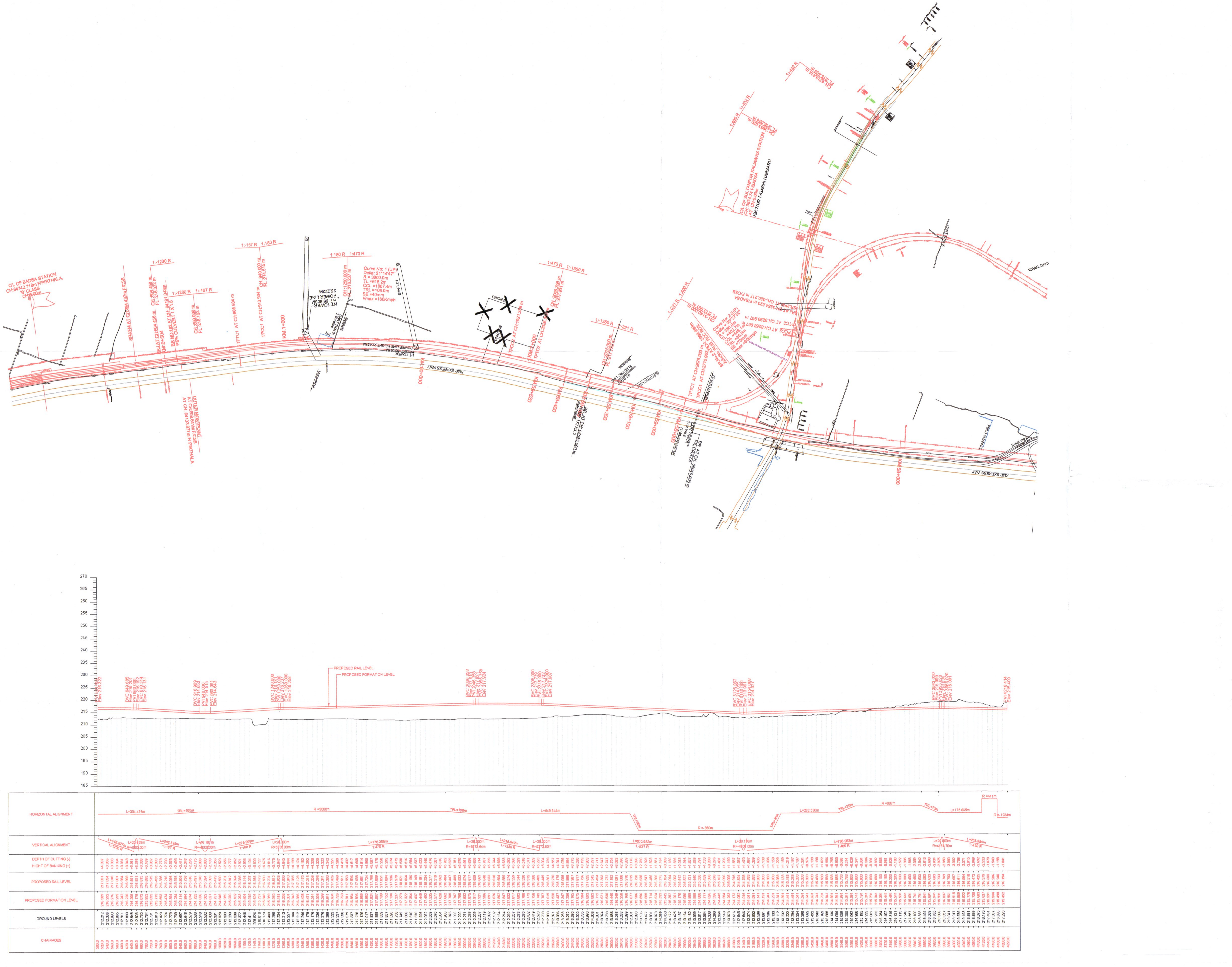
GC DRG.NO.	GC-HRIDC-C2-DRW-ALN-P&P-04001_A2		
ISSUE Dt:	11.11.2022	REVISED Dt:	24.12.2022

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES

TANMAY (AM DWG) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/REV-2	SHEET No. 1	
SCALE : H= 1:5000,V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022



LEGEND:

- EXISTING RAILWAY TRACK
- PROPOSED UP & DN LINE
- DISMANTLING WORKS
- PROPOSED DIVERSIONS
- EXISTING ROAD
- PRO.HORC BOUNDARY
- EXPRESSWAY BOUNDARY
- EXISTING RAILWAY BOUNDARY
- HT LINE
- ELECTRICAL LINE(LT)
- STREAM / CANAL / DRAIN
- WELL
- POND

F/CSB-FROM CENTER LINE OF STN BLDG	RH - RIGHT HANDED
TP1 & TP2 - TANGENT POINT	LH - LEFT HANDED
R - RADIUS	FM - FOULING MARK
CCL - CIRCULAR CURVE LENGTH	SRJ - STOCK RAIL JOINT
TL - TANGENT LENGTH	TS - TRAP SWITCH
TR - TRANSITION LENGTH	DE - DEAD END
SE - SUPERELEVATION	Rr - RESULTANT RADIUS
Δ - DEFLECTION ANGLE	D - DEGREE OF CURVE
CSR - CLEAR STANDING ROOM	RH - RELAY HUT
SSP - SUB SECTIONING & PARALLING POST	

NOTE:

1. ALL DIMENSIONS ARE SHOWN IN METRES.
2. CH:0.00 IS RECKONED FOR C.L OF STATION BUILDING.
3. EXISTING WORK SHOWN IN BLACK.
4. PROPOSED WORK SHOWN IN RED.
6. ISOLATION WILL BE PROVIDED AS PER STD .IIR.
7. STD IIR ELECTRONIC INTERLOCKING WITH MACL SIGNALLING WILL BE PROVIDED.
8. ALL POINTS AND CROSSINGS ARE TO BE PROVIDED WITH FAN SHAPED CURVED SWITCHES ON CONCRETE SLEEPER .
9. CHAINAGES ARE RECKONED FROM C.L OF PIRTHALA STATION
10. RULING GRADIENT FOR THIS SECTION IS 1 IN 150 COMPENSATED

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram 29/7	SHIV OM DWIVEDI CPM/HRIDC	Shiv Om 30/7
SUDHIR AGRAWAL DPD/CIVIL	29/7	UMA.M.RAO DGM/C/WEST	30/7/2022
KRISHAN CHAND SAINSI CRE/CIVIL	29/7/22		

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC DRG.NO. GC-HRIDC-C2-DRW-ALN-P&P-05001_A0

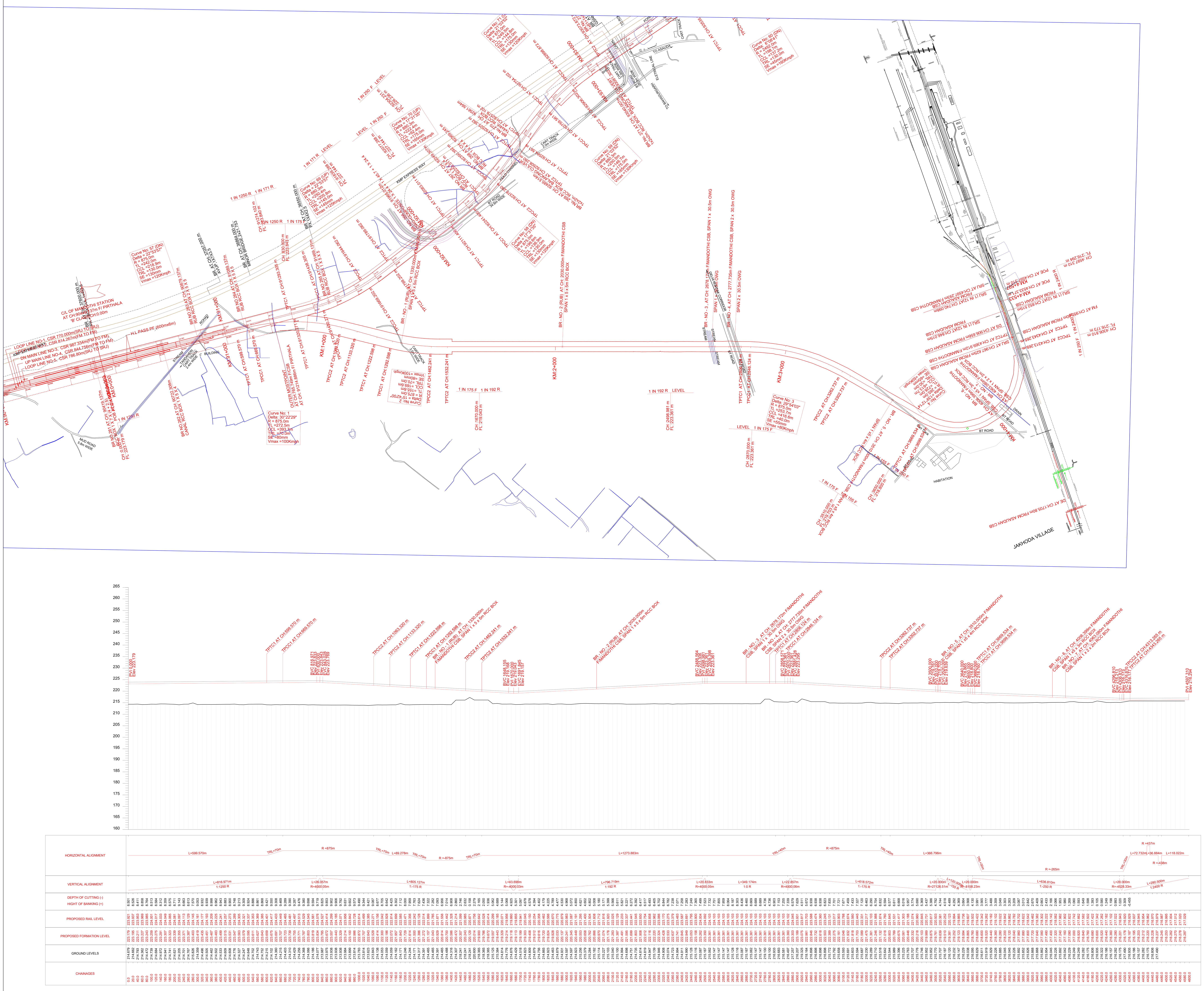
TITLE :

CONNECTIVITY TOWARDS SULTANPUR FROM BADSA

CONSULTANTS: aarvee associates architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
MANISHA (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO.AA/RLY/2245/HRIDC/ESP-07/REV-3	SHEET No. 1	
SCALE : 1:1000	ISSUED Dt: 26.11.2019	REV Dt: 28-07-2022



LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	PROW PROW
EXPRESSWAY BOUNDARY	ROW ROW
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	
PRO.TOE LINE	TOE TOE

NOTE:-
1. ALL DIMENSIONS ARE IN METRE UNLESS OTHERWISE STATED
2. ALL THE LEVELS ARE WITH RESPECT TO MEAN SEA LEVEL.
3. TRACK CETRE BETWEEN MAIN LINES OF HORC HAS BEEN KEPT AS MIN 5.30m
4. PUBLIC UTILITIES HT/LT LINES OFC CABLES WATER /SEWER LINES ETC INTERFERING WITH DFC TRACKS SHALL BE RELOCATED.
5. ARRANGEMENT & SIZE OF THE BRIDGE SHOWN IN THE DRAWING IS TENTATIVE AND MAY CHANGE AS PER THE APPROVED GAD.
6. VERTICAL CLEARANCE FROM LOWEST CONDUCTOR OF HT POWER LINE TO PROPOSED RAIL LEVEL ARE SHOWN

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD)

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS:-
1. BVC - BEGIN OF VERTICAL CURVE
2. PVI - POINT OF VERTICAL INTERSECTION
2. EVC - END OF VERTICAL CURVE

LEGEND FOR PROFILE :
PROPOSED RAIL PROFILE
PROPOSED FORMATION PROFILE
GROUND PROFILE

GC/HORC		HRIDC	
NAME / DEGINATION	SIGN	NAME / DEGINATION	SIGN
CHAHATEY RAM PD		SHIV OM DWIVEDI CPM/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		ABHISHEK DAS DGM/C/NORTH	
KRISHAN CHAND SAINSI CRE/CIVIL			

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

THE INFRASTRUCTURE PEOPLE
Member of the Surbana Jurong Group

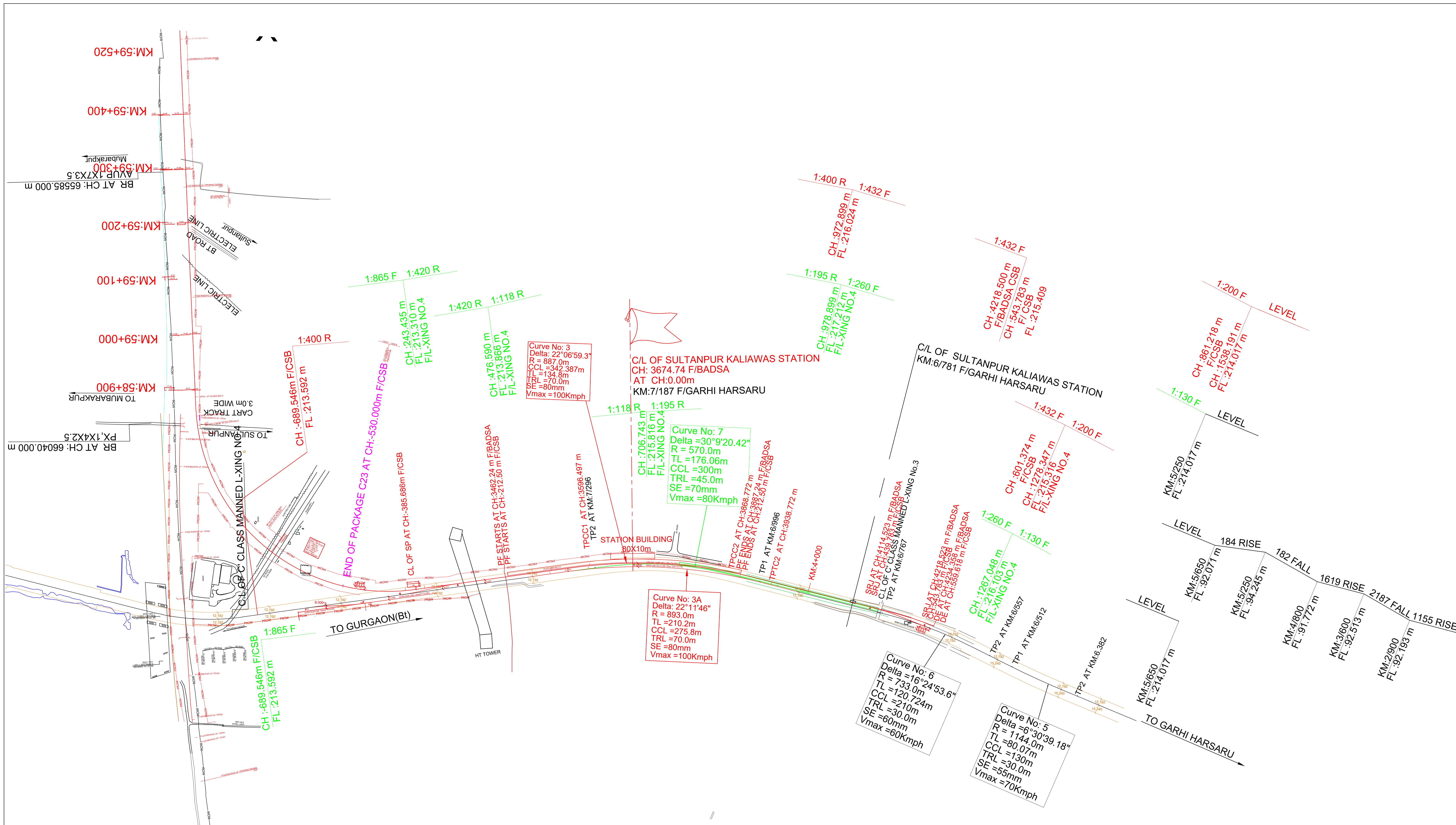
GC DRG.NO.

TITLE :
PLAN & LONGITUDINAL SECTION
MANDOTHI TO ASAUDHA CONNECTIVITY

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

AARVEE ASSOCIATES		
TANMAY (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

DRG.NO. AA/2245/AL/DR/P&P/R3	SHEET No.4 OF 4
SCALE : H = 1:5000 V = 1:500	ISSUED Dt: 26.11.2019	REV Dt: 06-08-2022



LEGEND:

EXISTING RAILWAY TRACK	
PROPOSED UP & DN LINE	
DISMANTLING WORKS	
PROPOSED DIVERSIONS	
EXISTING ROAD	
PRO.HORC BOUNDARY	PROW PROW
EXPRESSWAY BOUNDARY	ROW ROW
EXISTING RAILWAY BOUNDARY	
HT LINE	
ELECTRICAL LINE(LT)	
STREAM / CANAL / DRAIN	
WELL	
POND	

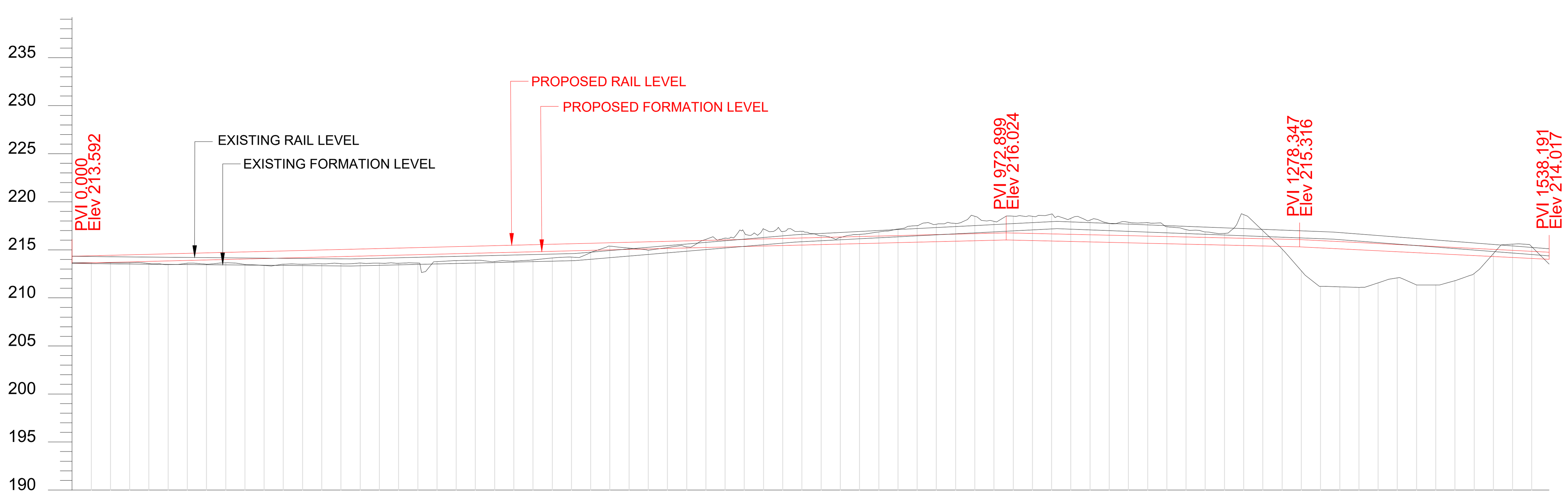
F/CSB-FROM CENTER LINE OF STN BLDG	RH - RIGHT HANDED
TP1 & TP2 - TANGENT POINT	LH - LEFT HANDED
R - RADIUS	FM - FOULING MARK
CCL - CIRCULAR CURVE LENGTH	SRJ - STOCK RAIL JOINT
TL - TANGENT LENGTH	TS - TRAP SWITCH
TR - TRANSITION LENGTH	DE - DEAD END
SE - SUPERELEVATION	Rr - RESULTANT RADIUS
Δ - DEFLECTION ANGLE	D - DEGREE OF CURVE
CSR - CLEAR STANDING ROOM	RH - RELAY HUT
SSP - SUB SECTIONING & PARALLING POST	

NOTE:

1. ALL DIMENSIONS ARE SHOWN IN METRES.
2. CH:0.00 IS RECKONED FOR C.L OF STATION BUILDING.
3. EXISTING WORK SHOWN IN BLACK.
4. PROPOSED WORK SHOWN IN RED.
6. ISOLATION WILL BE PROVIDED AS PER STD .IIR.
7. STD IIR ELECTRONIC INTERLOCKING WITH MACL SIGNALLING WILL BE PROVIDED.
8. ALL POINTS AND CROSSINGS ARE TO BE PROVIDED WITH FAN SHAPED CURVED SWITCHES ON CONCRETE SLEEPER .
9. CHAINAGES ARE RECKONED FROM C.L OF PIRTHALA STATION
10. RULING GRADIENT FOR THIS SECTION IS 1 IN 150 COMPENSATED

PROPOSED TRACK STRUCTURE (TO SUIT FOR 25T AXLE LOAD

I. FOR RAIL CORRIDOR: 160KMPH Speed
* TRACK = 60KG RAILS
* SLEEPER DENSITY : PSC SLEEPERS = 1660 No.S PER KM
* BALLAST CUSHION : 350mm
* ALL TURNOUTS ARE 1 in 12 UNLESS OTHERWISE SPECIFIED.



HORIZONTAL ALIGNMENT: TRL=70m — R =893m — TRL=70m

VERTICAL ALIGNMENT: L=972.899m 1:400 R — L=305.448m 1:-432 R — L=259.844m 1:-200 R

CHAINAGES	DIFF. B/W EXIST. RAIL LEVEL & PROP. RAIL LEVEL	PROPOSED RAIL LEVEL	PROPOSED FORMATION LEVEL	EXISITNG RAIL LEVEL	GROUND LEVELS
689.546	0.000	214.334	213.592	214.334	213.661
680.0	+0.073	214.384	213.642	214.311	213.648
660.0	+0.146	214.434	213.692	214.288	213.657
640.0	+0.220	214.484	213.742	214.264	213.667
620.0	+0.293	214.534	213.792	214.241	213.572
600.0	+0.366	214.584	213.842	214.218	213.452
580.0	+0.439	214.634	213.892	214.195	213.611
560.0	+0.512	214.684	213.942	214.172	213.505
540.0	+0.585	214.734	213.992	214.149	213.655
520.0	+0.658	214.784	214.042	214.126	213.478
500.0	+0.731	214.834	214.092	214.103	213.372
480.0	+0.805	214.884	214.142	214.079	213.496
460.0	+0.878	214.934	214.192	214.056	213.497
440.0	+0.892	214.984	214.242	214.092	213.548
420.0	+0.895	215.034	214.292	214.139	213.559
400.0	+0.897	215.084	214.342	214.187	213.624
380.0	+0.899	215.134	214.392	214.235	213.610
360.0	+0.902	215.184	214.442	214.282	213.611
340.0	+0.904	215.234	214.492	214.330	213.626
320.0	+0.906	215.284	214.542	214.378	213.776
300.0	+0.909	215.334	214.592	214.425	213.883
280.0	+0.911	215.384	214.642	214.473	213.921
260.0	+0.914	215.434	214.692	214.520	213.786
240.0	+0.916	215.484	214.742	214.568	213.827
220.0	+0.898	215.534	214.792	214.636	213.959
200.0	+0.778	215.584	214.842	214.806	214.152
180.0	+0.659	215.634	214.892	214.975	214.236
160.0	+0.539	215.684	214.942	215.145	214.718
140.0	+0.420	215.734	214.992	215.314	215.382
120.0	+0.300	215.784	215.042	215.484	215.178
100.0	+0.181	215.834	215.092	215.653	214.951
80.0	+0.061	215.884	215.142	215.823	215.237
60.0	-0.085	215.934	215.192	215.992	215.302
40.0	-0.178	215.984	215.242	216.162	216.095
20.0 0.0	-0.297	216.034	215.292	216.331	216.216
20.0	-0.417	216.084	215.342	216.501	216.794
40.0	-0.492	216.134	215.392	216.626	217.174
60.0	-0.544	216.184	215.442	216.728	216.909
80.0	-0.597	216.234	215.492	216.831	216.918
100.0	-0.650	216.284	215.542	216.934	216.458
120.0	-0.702	216.334	215.592	217.036	216.300
140.0	-0.755	216.384	215.642	217.139	216.612
160.0	-0.807	216.434	215.692	217.241	216.855
180.0	-0.860	216.484	215.742	217.344	217.167
200.0	-0.912	216.534	215.792	217.446	217.521
220.0	-0.965	216.584	215.842	217.549	217.669
240.0	-1.018	216.634	215.892	217.652	217.755
260.0	-1.070	216.684	215.942	217.754	218.497
280.0	-1.123	216.734	215.992	217.857	217.966
300.0	-1.199	216.750	216.007	217.949	218.497
320.0	-1.169	216.703	215.961	217.872	218.493
340.0	-1.139	216.657	215.914	217.796	218.726
360.0	-1.109	216.610	215.868	217.719	218.274
380.0	-1.078	216.564	215.822	217.642	218.094
400.0	-1.047	216.518	215.775	217.565	217.750
420.0	-1.017	216.471	215.729	217.488	217.871
440.0	-0.986	216.425	215.683	217.411	217.829
460.0	-0.955	216.379	215.636	217.334	217.407
480.0	-0.925	216.332	215.590	217.257	217.114
500.0	-0.894	216.286	215.544	217.180	216.861
520.0	-0.863	216.240	215.497	217.103	216.709
540.0	-0.833	216.193	215.451	217.026	218.659
560.0	-0.802	216.147	215.405	216.949	216.979
580.0	-0.771	216.101	215.358	216.872	215.086
600.0	-0.696	216.050	215.307	216.746	212.818
620.0	-0.642	215.950	215.207	216.592	211.204
640.0	-0.588	215.850	215.107	216.438	211.150
660.0	-0.534	215.750	215.007	216.284	211.076
680.0	-0.480	215.650	214.907	216.130	211.569
700.0	-0.426	215.550	214.807	215.976	212.076
720.0	-0.373	215.450	214.707	215.823	211.348
740.0	-0.319	215.350	214.607	215.669	211.344
760.0	-0.265	215.250	214.507	215.515	211.793
780.0	-0.211	215.150	214.407	215.361	212.541
800.0	-0.157	215.050	214.307	215.207	214.616
820.0	-0.102	214.950	214.207	215.053	215.584
840.0	-0.050	214.850	214.107	214.900	215.320
860.0	-0.010	214.750	214.017	214.760	213.514

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD	Chahatey Ram	R.R.KUMAR GM IP&P/HRIDC	
SUDHIR AGRAWAL DPD/CIVIL		UMA.M.RAO DGM/C/WEST	
KRISHAN CHAND SAINSI CRE/CIVIL			

NORTHERN RAILWAY

DRM-DLI	
ADRM-INFRA-DLI	
SRDEN-CO-DLI	
SRDOM- DLI	
SRDSTE-DLI	
SRDEE-TRD-DLI	
SRDEN-5-DLI	
ADEN-DEE	
SSE-PWAY-GGN	
SSE-W-GGN	

NR.DIVL FILE NO.	
NR.DIVL PLAN NO.	
NRHQ CASE NO.	
NRHQ PLAN NO.	

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

GENERAL CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC

TITLE :
RE-GRADING OF GARHI HARSARU-FARUKHNAGAR MAIN LINE OF SULTANPUR STATION YARD (CONCEPTUAL)

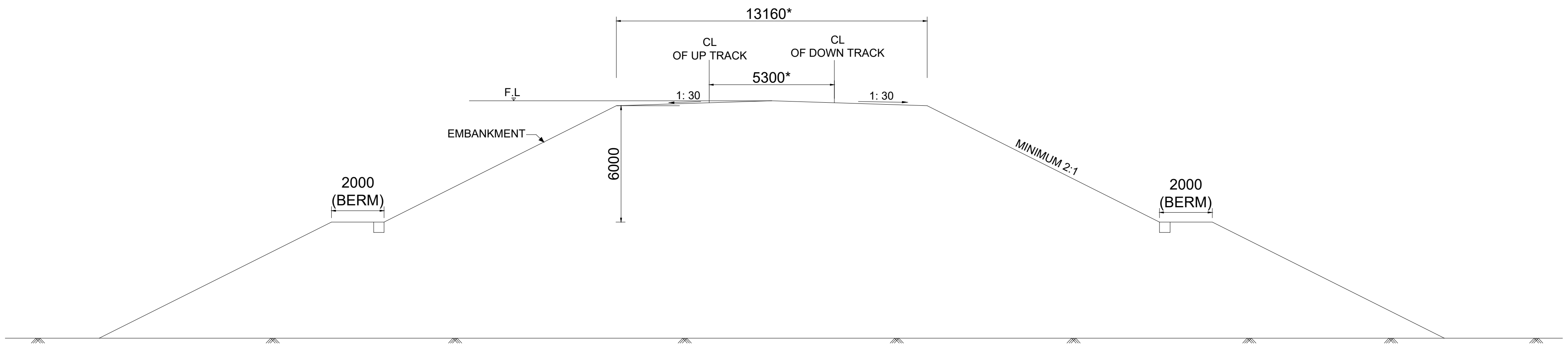
GC DRG.NO. GC-HRID-C2-DRW-ALN-P&P-06001-A1
ISSUE Dt: 11.11.2022 REVISED Dt: 24.12.2022

CONSULTANTS :
aarvee associates
architects engineers & consultants pvt.ltd.
Ravula Residency, Srinagar Colony Main Rd., Hyderabad-82, India
Tel: 91-40-23737633; Fax: 91-40-23736277
e-mail: railways@aarvee.net; web:www.aarvee.net

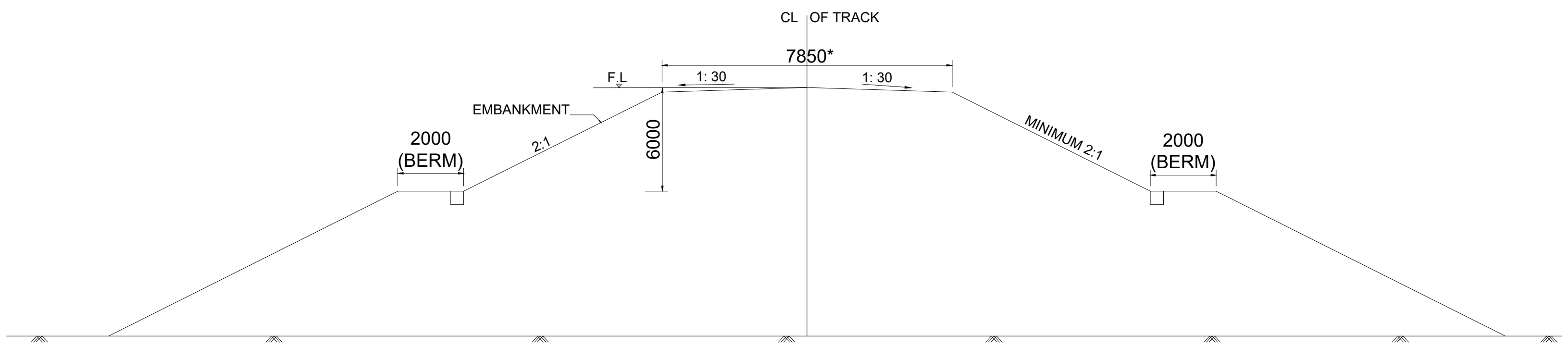
AARVEE ASSOCIATES

MANISHA (AM CAD) DRAWN	G.PRASAD (M) CHECKED	N.J. RAO (VP) APPROVED

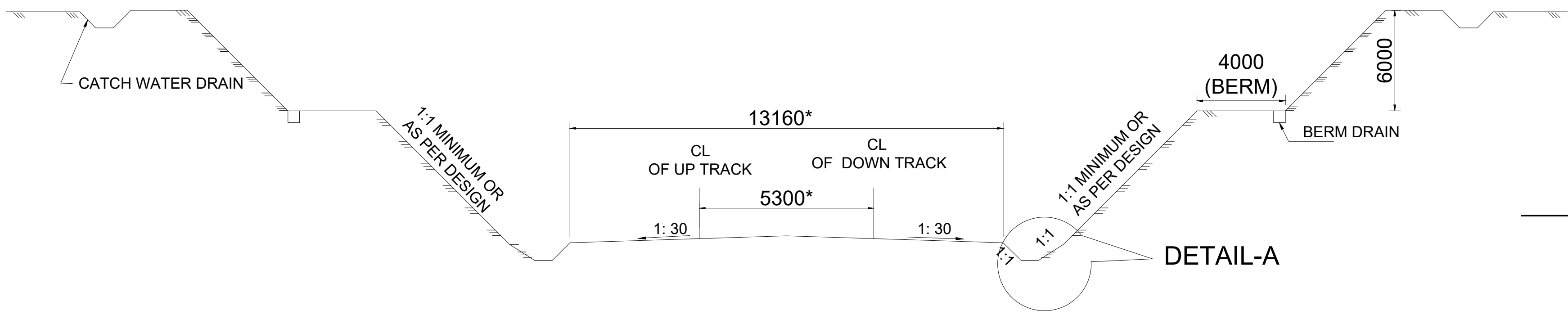
DRG.NO. AA/RLY/2245/HRIDC/ESP-07/REV-3 | SHEET No. 1
SCALE : 1:1000 | ISSUED Dt: 26.11.2019 | REV Dt: 18-07-2022



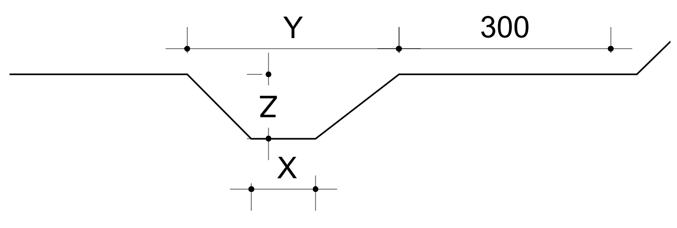
TYPICAL CROSS-SECTION OF EMBANKMENT
(FOR DOUBLE TRACK)



TYPICAL CROSS-SECTION OF EMBANKMENT
(FOR SINGLE TRACK)



TYPICAL CROSS-SECTION OF CUTTING
(FOR DOUBLE TRACK)



DETAIL-A

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM DRAWING ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. DEPTH OF BALLAST CUSHION SHOULD BE PROVIDED AS PER PARA 212(2) OF IRPWM.
4. CROSS SLOPE OF 1IN 30 SHALL BE PROVIDED.
5. MINIMUM FORMATION WIDTH OF 13160 MM SHALL BE ENSURED FOR NEW WORKS IN BOTH EMBANKMENT AND IN CUTTING (EXCLUDING SIDE DRAIN)
6. * FORMATION WIDTH SHALL BE INCREASED BASED ON CURVE & SUPER ELEVATION AS PER IRSOD.
7. X, Y, Z DIMENSIONS SHALL BE AS PER DESIGN.

PROJECT:
HARYANA ORBITAL RAIL CORRIDOR
CONNECTING PALWAL TO SONIPAT BYPASSING DELHI AREA BY LINKING ASAOTI-PATLI-SULTANPUR-ASAUDAH BY NEW ELECTRIFIED BG DOUBLE LINE

CLIENT:
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.

CONSULTANT:
GENERAL CONSULTANT FOR HARYANA ORBITAL RAIL CORRIDOR
RITES Limited in consortium with SMEC International Pty. Ltd.

RITES THE INFRASTRUCTURE PEOPLE | SMEC Member of the Surbana Jurong Group

GC/HORC		HRIDC	
NAME / DESIGNATION	SIGN	NAME / DESIGNATION	SIGN
CHAHATEY RAM PD		R. R. KUMAR GM/ IP&P	
SUDHIR AGRAWAL DPD/CIVIL		RAJU SOLANKI DGM/C-SOUTH	
REETU PATIAL CDE/ CIVIL			

TITLE:- CONCEPTUAL PLAN
TYPICAL EMBANKMENT/CUTTING PROFILE

DRG. NO.	GC-HRIDC-SK-GEN-001_A2	SHEET NO.
SCALE : AS SHOWN	ISSUE DATE 07-11-2022	REVISED DATE 09.01.2023

PART 2 – Employer's Requirements

Section VII-4: ESHS Manual

Section VII- 4: Employer's Requirements

Environment, Social, Health and Safety Management Manual

Table of Contents

1. ESHS FRAMEWORK

1.1. General

1.1.1. The Contractor shall be responsible for Environment, Social, Health and Safety (ESHS) on the site and any other areas being used by him for the purposes of the Contract. Each Contractor shall develop his own contract specific ESHS Management Plan, which will represent his approach to the management of ESHS activities on his work, sites under the Contract with the Employer. The ESHS Management Plan should contain all the measures in the project Environmental and Social Management Plan (ESMP) which is part of the EIA.

1.1.2. The Contractor shall ensure that all appropriate ESHS measures are implemented throughout the execution of the Works.

1.2. Scope

1.2.1. The Environment, Social, Health and Safety Management Manual defines the principal requirement of the Employer and forms an essential part of the overall Environment, Social, Health and Safety Management System proposed to be employed by the Employer for the construction of the Project.

1.3. Definition

a) HEALTH & SAFETY – Conditions and factors that affect the well-being of employees, temporary workers, Contractor personnel, visitors and any other person at the workplace;

b) ENVIRONMENT – Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interaction;

c) ENVIRONMENT ASPECT – Element of an organization's activities or products or services that can interact with the environment;

d) ENVIRONMENT IMPACT – Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects;

e) HAZARD – Source, situation, or act with a potential for harm in terms of human injury or ill health or a combination of these;

f) Ill Health – Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation;

g) Incident – Work related event (s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred:

- "Accident" is an incident which has given rise to injury, ill health or fatality;
- "Emergency" is an incident having potential to affect many persons orsevere property damage;
- "Near Miss" is an incident or a situation with clear potential for an undesirable outcome to occur, even though no actual negative consequenceshappened. In other words, it is an event with potential to cause injury, property damage, environmental release or an adverse community reaction; and
- "Dangerous Occurrence" is an unplanned and undesired occurrence(incident) which has the potential to cause injury, and which may or maynot cause damage to property, equipment or the environment.

h) AUDIT – Systematic examination to determine whether activities planned are implemented effectively and related results are suitable for achieving theorganization policy and objectives;

i) INTERESTED PARTIES – Individual or group concerned with or affected by the ESHS Management Performance of an Organization;

j) NON-CONFORMITY – Any deviation from work standards, practices, procedures, regulations, management system performance, etc. that could either directly or indirectly lead to injury or illness, property damage, damage to workplace environment, or a combination of these;

k) OBJECTIVES – Goals in terms of ESHS Management Performance that an organization sets itself to achieve;

l) ESHS MANAGEMENT SYSTEM – Parts of overall management system that facilitates the management of the ESHS risks associated with the business of the organization. This includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's ESHS Management Policy;

m) ORGANIZATION – Company, operation, firm enterprise, institution or association, or part thereof, whether incorporated or not, public or private, that has its own functions and administration;

n) PERFORMANCE – Measurable results of the ESHS Management System, related to the organization's control on environment, health and safety risks, based on its ESHS Management Policy and objectives;

o) RISK – Combination of the likelihood and consequences of a hazardous event occurring;

p) RISK ASSESSMENT – Overall process of establishing the magnitude of risk and deciding whether the risk is tolerable;

q) ACCEPTABLE RISK – Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own ESHS Policy;

r) DEVIATION – Is defined as something not in compliance with quality standard, specification or measuring requirements, or as deviations from specified procedures or way of working within production, environment, working environment (safety) or security;

s) CORRECTIVE ACTION – Action taken to eliminate the causes of an existing non-conformity, defect or other undesirable situation;

t) PREVENTIVE ACTION – Action taken to eliminate the causes of a potential non-conformity, defect or other undesirable situation to prevent occurrence or recurrences;

u) ENGINEER – Employer's Representative

v) Abbreviation

- "Ministry of Environment, Forest and Climate Change, Government of India" is abbreviated as MoEFCC;
- "Central Pollution Control Board" is abbreviated as CPCB;
- "State Pollution Control Board" is abbreviated as SPCB;

- "Haryana Pollution Control Board" is abbreviated as HPCB;
- "National Green Tribunal" is abbreviated as NGT;
- The use of "shall" indicates a mandatory requirement. "ESHS" means Environment, Social, Health and Safety;
- "Haryana Rail Infrastructure Development Corporation Limited" is the Employer abbreviated as HRIDC;
- "ESHS Manager" is an officer approved by the Engineer who is overall responsible for monitoring all ESHS functions prescribed in this document on behalf of the Contractor;
- "BOCWA" Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and amendment done thereafter;
- "BOCWR" Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005 and amendment done thereafter;
- "BOCWWCA" Building and Other Construction Workers' Welfare Cess Act, 1996;
- "BOCWWCR" Building and Other Construction Workers' Welfare Cess Rules, 1998;
- "CHIEF INSPECTOR" is the Chief Inspector of Inspection of Building and Other Constructions of Government of Haryana;
- "HIRA" is Hazard Identification and Risk Assessment; and

1.4. Application of This Document

1.4.1. This document applies to all aspects of the Contractor's Scope of Work including Subcontractors and all other agencies. There shall be no activity associated to the Contract, which is exempted from the purview of this document.

1.5. Purpose of This Document

1.5.1. The objective of these guidelines is to ensure that adequate precautions are taken for incident/occupational illness free safe work execution as well as to avoid harmful effects on the environment and social during construction.

1.5.2. This document:

a) Describes the Environment, Social, Health and Safety interfaces between theEngineer and the Contractor.

b) Details the processes by which the Contractor shall manage Environment, Social Health and Safety issues while carrying out the work under the contract.

1.5.3. These requirements shall be read together with, ISO 45001: 2018 Occupational Health and Safety Management System and ISO 14001: 2015 Environmental Management Systems.

2. ESHS MANAGEMENT

2.1. General

2.1.1. This document defines the principal requirements to be practiced at the site at all times.

2.2. ESHS Targets and Goals

2.2.1. Following ESHS targets and goals shall be set and achieved by the Contractor/Subcontractor based on time bound work plan:

a) Zero total recordable injuries;

b) Zero non-conformances in respect of statutory laws related to Environment, Health, Social andWelfare measures, living conditions and Safety regulations.

c) Total compliance of recording and reporting of all types of incidents.

d) 100% compliance on Safety Induction of all personnel

e) Total compliance of conducting inspections and audits as per approved ESHS Management Plan;

f) 100% incident recording and reporting;

g) 100% adherence to usage of appropriate PPEs at work;

h) Executing construction work with least disturbance to environment, road/rail users, nearby residential area and traffic;

i) Minimize waste generated at sites and maximize reuse of materials;

j) Maintaining environment conditions of site as per statutory requirement of HPCB, NGT etc. to avoid penalty;

k) To achieve construction site as zero discharge site as far as possible.

2.3. Contractor’s Obligation to Abide by Mandatory Legislations and Standards

2.3.1. The construction works shall be undertaken in accordance with the Employer’s ESHS Management Policy and Management Systems as amended from time to time provided in ESHS Management Manual.

2.3.2. The construction works shall be undertaken in accordance with all updated applicable legislation listed below, but not limiting to:

a) Indian Electricity Act 2003 and Electricity Rules, 2005;

b) National Building Code, 2016;

c) Factories Act, 1948 and state respective factory Rules;

d) Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules, 1989;

e) Indian Road Congress Code IRC: SP: 55-2014 ‘Guidelines on Safety in Road Construction Zones’;

f) The Petroleum Act, 1934 and Rules, 1976;

g) Gas Cylinder Rules, 2003;

h) Indian Explosives Act, 1884, along with the Explosives Substance Act, 1908 andthe Explosives Rules, 1983;

i) Indian Railway Manual of AC Traction maintenance and operation.

j) IPR way Manual; and

k) Environmental and Social Legislations as listed in Clause 6.0 of this document.

2.4. Contractor's Environmental, Social, Health and Safety Management Policy and Plan

2.4.1. The Contractor as per Rule 39 of the BOCW Central Rules shall formulate an Environment, Social, Health & Safety policy and display it at conspicuous places at work sites in English and Hindi so that the policy shall be understood by majority of the construction workers. The policy shall contain the following as minimum coverage:

a) The intention and commitments of the Contractor regarding Environment, Social,Health & Safety protection of the workers;

b) Organizational arrangement made to carry out the policy specifying the responsibilities at different levels of hierarchy;

c) Responsibilities of the Contractors, Subcontractor, transporter or other agenciesinvolved in the construction work ;

d) Techniques and methods for assessment of Aspects/Impact and risk to safety andhealth and remedial measures;

e) Arrangement for training of workers, supervisors or other persons engaged in theconstruction work;

f) Other arrangements for making the policy more effective.

2.4.2. The Contractor shall revise the policy whenever any modification having implication on the Environment, Social, Health and Safety of the workers is made or any new construction work, substances, or technique are introduced which have implication on environment, health and safety of workers.

2.4.3. The contractor shall submit ESHS Management plan for review by the engineer within 28 days after the commencement date.

2.4.4. The Contractor shall revise and submit the ESHS Management Plan if at any time the ESHS Management Plan is insufficient in the Engineer's opinion. The Contractor shall within 14 days submit the revised ESHS Management Plan to the Engineer for review.

2.4.5. Any omissions, inconsistencies, and errors in the ESHS Management Plan or the Engineer's acceptance or rejection of the ESHS Management Plan and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not be excused for any failure by the Contractor to adopt proper and recognized safety practices throughout the execution of the Works. The Contractor shall adhere to the ESHS Management Plan and shall ensure, as far as practically possible, that all supervisors and subcontractors of all tiers each have a copy of the ESHS Management Plan on the site and comply with its provisions.

2.4.6. The details of contents to be covered in the ESHS Management Plans are given in Attachment -1[Contents of ESHS Management Plan] of this document.

2.4.7. Contractor will inform AIIB of any significant ES events such as accidents, near misses, fatalities. AIIB is to be informed within two days of the event.

2.5. Designer's Role

2.5.1. The Designer's primary role includes to minimize the risk to environment, safety and health of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and anyone else like adjoining road users/public, who might be affected by the work.

2.5.2. Every temporary structure like scaffold, temporary deck, earth retaining structures etc. shall be properly designed.

2.6. Site ESHS Organisation

2.6.1. The Contractor shall appoint the required ESHS Management Personnel as prescribed in the

Contract.

In order to effectively implement labour welfare provisions and to interact on such provisions with the Employer and the statutory authorities enforcing the labour welfare legislations, every Contractor shall employ fulltime, qualified, and experienced Labour Welfare Officer.

2.6.2. **Conduct and Competency**

The Contractor shall ensure that all personnel are competent to perform the job assigned to them. In the event that the Contractor is unable to demonstrate the competency of any person whose activities can directly impact the Works' Environment, Social, Health & Safety performance, the Engineer shall remove that person from the site without any procedural formalities.

Labor Code of Conduct: The Contractor shall have a Code of Conduct for the Contractor's Personnel. The Contractor shall ensure that each Contractor's Personnel is provided a copy of this Code of Conduct, written in a language comprehensible to that person, and shall seek to obtain that person's signature acknowledging receipt of the same.

2.6.3. **Approval from The Engineer**

The name, address, educational qualification, work experience and health condition of each ESHS personnel deployed shall be submitted to the Engineer for approval well before the start of the Works or before deployment whichever is earlier. These personnel are authorized to work only after approval of the Engineer. In case any ESHS personnel leaves the Contractor, the same shall be intimated to the Engineer within a week. Non-informing the employer will attract penalty. The Contractor shall recruit new personnel and fill up the vacancy before relieving a person. Proper handing over of all the documents shall be ensured before relieving a person.

2.6.4. The Contractor shall provide all ESHS Management Personnel with such facilities, equipment and information that are necessary to enable them to discharge their duties effectively. The minimum requirements of such facilities/equipment to be provided for ESHS Management Personnel are given in Attachment-4 [General Instruction:ESHS/GI/001].

2.7. Responsibility of ESHS Personnel

2.7.1. PICOW (Person In-Charge of Work)

a) "Person in Charge of Work" under whose supervision, the Workers operate as per approved method statement and ESHS Management Manual.

b) PICOW shall lead/supervise and direct the Workers to undertake the work in a safe manner.

c) Each Request for Inspection (RFI) must indicate the name of PICOW for that work.

2.7.2. Responsibility of a PICOW

PICOW should ensure that:

a) A safe system of work is adopted;

b) Everyone in the group is briefed and understand the system of work before work starts;

c) The current system of work is altered whenever there is any change in conditions or circumstances make it necessary and ensure that everyone understands the new arrangements; and

d) The work is stopped and everyone moved to a position of safety immediately, should there be any doubt whether the work may safely continue.

2.7.3. All ESHS Management Personnel are to report to the ESHS Manager who shall always report directly to the Contractor's Project Manager. Their primary role is to oversee environment, social, health and safety aspects at work site. The Engineer shall always monitor adherence to this procedure. In case of non-adherence penalty shall be levied.

2.8. ESHS Committee

2.8.1. The Contractor shall form site ESHS Committee within 60 days of award of the Contract and notification regarding the same shall be communicated to the members.

2.8.2. The Terms of Reference for the site ESHS Committees shall be as follows:

a) To oversee implementation of the Contractor's Environment, Social, Health and Safety policies and practices;

b) To monitor the adequacy of the Contractor's ESHS Management Plan and ensure its implementation;

c) To review ESHS training;

d) To review the Contractor's ESHS monthly reports;

e) To identify probable causes of accident and unsafe practices in construction work and to suggest remedial measures;

f) To stimulate interest of the Workers in environment, health and safety by organizing environment/safety week, safety competition, talks and film-shows on environment/safety, preparing posters or taking similar other measures as and when required or as necessary;

g) To go around the site with a view to check unsafe practices and detect unsafe conditions and to recommend remedial measures for their rectifications including first-aid medical and welfare facilities;

h) Committee team members should perform a site inspection before every committee meeting and to monitor ESHS inspection reports;

i) To bring to the Notice of the Engineer hazards associated with use, handling and maintenance of the equipment used during the course of construction work;

j) To suggest measures for improving environment, social, health and safety in construction work at the site;

k) To investigate the health hazards associated with handling different types of explosives, chemicals, and other construction materials and to suggest remedial measures including personal protective equipment; and

l) To review the last ESHS committee meeting minutes and the remedial measures taken for Non-Compliance.

2.8.3. Site ESHS Committee meeting shall be conducted once in a calendar month and participation of following members shall be ensured.

Chairman	Project Manager
Secretary	ESHS Manager (Will be nominated by Project Manager)
Members	i) Contractor's ESHS staff. ii) Labour Welfare Officer; iii) In -charge of Plant and Machinery & site Electricals; iv) In-charge of Special Work Operations (e.g. bridge, viaduct, and tunnel, etc.); v) In-charge of Stores; vi) Subcontractor's representative; and vii) Workers' representatives;
Engineer's Representatives	To be nominated by the Engineer

2.8.4 Minimum time between two monthly ESHS Committee meetings

A minimum period of 21 days shall be maintained between any two ESHS monthly committee meetings.

2.8.5. Agenda

The Secretary shall circulate the agenda of the meeting at least seven working days in advance of the scheduled date of the meeting to all members as well as to the Employer.

2.8.6. The agenda should broadly cover the following:

a) Chairman's overview of ESHS Management Performance;
b) Confirmation of minutes of last meeting;
c) Previous month ESHS statistics;
d) Incident and accident investigation/Dangerous occurrence/Near miss report;
e) Site ESHS inspection and compliance report;
f) The Contractors' ESHS issues;
g) Report from the Employer and Engineer;
h) Non-compliances raised by Engineer/Statutory Authorities;
i) Report and compliance of GRC; and
j) Any other concern.

2.8.7. In case of station and other contiguous areas where more than one main Contractor is working together, the Engineer shall instruct the other Contractors/ Sub-contractors to join for the monthly ESHS committee meeting of the main civil Contractor, to discuss and decide about the common provision of safety, security, lighting, toilet, drinking water etc. and sharing the maintenance cost of the same etc.

2.8.8. The Minutes of the Meeting shall be prepared as per the format provided and sent to all members within 2 working days by mail. Minutes of ESHS Committee Meeting shall also be displayed on the notice board for wider publicity to all concerned.

2.8.9. The chairman shall inform the members of any outstanding issues in the meeting and in case of repeated offence/ non-compliance by some members or other Subcontractors shall impose suitable disciplinary action including provisions of monetary penalty as per Clause 7. [Financial Deduction/Withholding].

2.8.10. In addition, there shall be a Project ESHS Committee whose composition shall be as follows:

Chairman	Project Director
Secretary	ESHS Manager (Will be nominated by PD)
Members	i) Deputy Project Director/Civil ii) Project Manager along with ESHS manager from each Contract Package iii) ESHS experts of GC
Employer's Representatives	Chief Project Manager

2.8.11. Project ESHS Committee shall also meet once a month after the meeting of site ESHS Committee. Project ESHS Committee shall oversee the implementation of ESHS Policy and ESHS Management Plan of the Contractor in execution of the Project. This Committee shall also redress the grievances/complaints/representations received from public, other stakeholders and employees of the Contractor and Subcontractors. The agenda of the meeting shall be circulated by the Secretary of the Committee after taking approval from the Project Director.

2.9. ID Card and ESHS Induction

2.9.1. The Contractor shall ensure that all personnel working at the site receive an induction ESHS training immediately on the first day of joining explaining the nature of the work, the hazards that may be encountered during the site work. Personnel shall only be deployed at site once he/she has completed ESHS induction. The training shall cover the contents as given in Clause 8, Attachment-4[General Instruction: ESHS/GI/002].

2.9.2. All personnel shall be issued a photo identity card as per the format given in Clause 8, Attachment-4[General Instruction: ESHS/GI/003].

2.9.3. The Contractor shall also issue a Personnel pocket ESHS Booklet in a language known to the Workers, which provides information on ESHS and emergency procedures

2.10. Other ESHS Training

2.10.1. The Contractor shall organize the ESHS training to engage managers, supervisors and other personnel in behavioural change and improve safety performance. The contents of ESHS training to managers/supervisors as given in Attachment-4[General Instruction: GI/005].

2.10.2. The Contractor shall provide a training/workshop on ESHS to all its workers/staff/employees/subcontractors of at least 2 days. It shall be completed in various modules and each employee/worker shall have a record of completing all modules.

2.10.3. On-the spot practical skill development training on height safety including scaffold safety, crane safety, welding safety, electrical safety, and traffic safety for marshals shall also be conducted.

2.10.4. Every employee including workman shall take a safety oath followed by toolbox talk every day.

2.10.5. All vehicles and machine drivers including heavy work vehicle and machine operators shall be trained on defensive driving with necessary certificate or license.

2.11. ESHS Inspection

2.11.1. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.11.2. The purpose of ESHS inspection is to identify any deviation in construction activities and operations, machinery, plant and equipment and processes against the ESHS Management Plan and its supplementary procedures and programs.

2.11.3. The Contractor shall initiate a monthly joint site ESHS Management inspection with the Engineer and report shall be generated on the same day with the corrective action and accepted target date (within a week) by the Engineer.

2.11.4. The Compliance of the joint inspection "Non-Conformance" shall be witnessed/accepted by the Engineer.

2.11.5. The Contractor shall submit follow up compliance report of the ESHS inspection report within six days of the date of Inspection.

2.11.6. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.11.7. Following ESHS inspections program shall be adopted:

a) Planned general inspection;
b) Routine inspection;
c) Specific inspection; and
d) Other inspection.

2.11.8. Planned general inspections are performed at predetermined intervals. Inspections that will be classified under this inspection program are:

a) Monthly Contractor and subcontractor's site safety committee inspection;
b) Weekly ESHS inspection by construction supervisors (the Contractor and the Subcontractor); and
c) Daily ESHS inspection by the Contractor site ESHS team.

2.11.9. Routine inspections are often referring to the inspection of the site, equipment and temporary structures performed by the site and equipment operators and temporary structure erectors.

Inspections that will be classified under this inspection program are:

a) Daily inspection of plant and equipment by operators;
b) Weekly inspection of scaffold by scaffolding supervisors;
c) Monthly Inspection of electrical hand tools by competent electrical supervisors;
d) Quarterly inspection of temporary electrical systems by competent electrical supervisors; and
e) Half-yearly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent persons.

f) Quarterly inspection of lifting gears, tools tackles and appliances.

g) Quarterly colour coding of lifting gears, tools & tackles. The recommended colour coding for the 4 quarters of the years shall be as under

i) January – March: GREEN

ii) April – June: YELLOW

iii) July – September: BLUE

iv) October – December: WHITE

2.11.10. The list mentioned above is not exhaustive. The Contractor may add additional categories. The ESHS Manager will ensure that a system of routine inspections is carried out periodically to all plants, equipment, powered tools and any other temporary structures that will pose a hazard to operators and workmen.

2.11.11. Specific Inspection

Specific inspections are performed on activities without a predetermined date. Competent supervisors usually perform inspections for ensuring an activity whether it is executed in accordance to a general set of rules; Method Statement submitted or developed procedures.

The following are examples that will be commonly performed as required on the site:

a) Inspection performed before a heavy lifting operation;

b) Inspection performed before and after the entry of person into a confined space;

c) Inspection performed before and after a welding and gas cutting operation;

d) Inspection of formwork before concreting by formwork erector.

The list mentioned above is not exhaustive. The Contractor shall ensure that a competent supervisor inspects all high-risk processes and activities.

2.11.12. Other inspections include the following:

a) Mandatory inspections by Labour Department of Government of Haryana; and

b) HRIDC site ESHS management team.

c) Inspections by Central Pollution Control Board, Haryana Pollution Control Board, Ministry of Environment and Forest and Climate Change, National Green Tribunal etc.

2.11.13. The Contractor shall prepare all required safety inspection checklist for all activity operations and equipment. Checklists will be prepared based on the Indian SafetyStandards, Rules and Regulations and the Works requirements.

2.11.14. All inspection records and reports will be properly kept and filed for audit purpose. Inspection reports of planned general inspection and routine inspection will be used for discussion during safety committee meetings.

2.11.15. The contractor project manager & ESHS expert with site team shall be participating in the ESHS inspection.

2.12. ESHS Audit

2.12.1. The purpose and scope of ESHS Audit is to assess potential risk, liabilities and the degree of compliance of the ESHS Management Plan and its supplementary procedures and programs against applicable and current ESHS legislation regulations and the Works requirements.

2.12.2. The Contactor's project manager shall hold the ultimate responsibility in ensuring implementation of ESHS audit program during the construction work.

2.12.3. **Monthly Audit Rating Score (MARS**)

2.12.4. Monthly Audit Rating Score (MARS) will be performed once in a month. A team consisting of the Contractor's project manager and the Engineer's representative based on the pre-designed score-rating format will conduct it.

2.12.5. This Monthly ESHS Audit Rating Score (MARS) report will enable the Engineer to evaluate the general compliance by the Contractor with the Conditions of Contract, and the ESHS Management Plan. A Minimum Compliance level to achieve 75% overall Audit Rating is essentially required. Falling this, the Engineer will take punitive action which includes non-processing of running account bills.

2.12.6. The Contractor's project manager accompanied by the Engineer's representatives shall carry out the Audit. The Contractor's senior manager and the ESHS in-charge should also be invited to attend.

2.12.7. Timing

The Monthly Audit Rating Score (MARS) should be conducted at least 7 days prior to the scheduled date of monthly ESHS Committee Meeting.

2.12.8. Evaluation

The numerical scoring has been weighed on a 1-10 scale. The audit team will use their observations noted in evaluating the points to be awarded against each of the elements of the audited section. Wherever some topics and sub-topics are not applicable the score rating need not be given. The overall audit ratings shall be achieved by:

$$\text{Overall Audit rating} = \frac{\text{Actual Score Achieved}}{\text{Maximum Possible Score}} \times 100$$

The criticality of the required actions for the respective sections of the Audit will be classified as:

S.No.	Score	Description	Action
1	< 60%	Immediate	Require the Contractor to rectify within 24 hours
2	< 75%	Improvement Necessary	The Contractor rectification within 7 days and confirmed in writing to the Engineer
3	< 90%	Improvement Desirable	The Contractor rectification within 1 month and confirmed in writing to the Engineer

2.12.9. Report

A copy of each Audit Report will be sent to the Engineer and to all subcontractors, with whom it will then be discussed in detail at the monthly ESHS Committee Meeting to ensure that any corrective actions are agreed upon.

2.12.10. **Monthly Electrical Safety Audit**

2.12.11. A team comprising of Contractor's Senior ESHS (Electrical) Manager along with the Engineer representatives shall conduct a monthly electrical safety audit covering the following and submit the report to the Engineer. The report shall be submitted in the format as prescribed by the Engineer. Format given in Clause 8, Attachment-4[General Instruction: ESHS/GI/010]

- i) Electrical accidents investigation findings and remedy.
- ii) Adequacy of power generation and power requirements.
- iii) Power distribution and transmission system in place.
- iv) Updated electrical single line diagram showing the current condition of power source and distribution including the IP rated DBs arrangement.

v) Electrical Protection devices-selection, installation and maintenance.
vi) Earth or ground connection and earth pit maintenance details.
vii) Education and training of electrical personnel undertaken.
viii) Routine electrical inspection details.
ix) Electrical maintenance system and register
x) Name plate details of major electrical equipment.
xi) Classified zones in the site, if any

2.12.12. **External ESHS Audit**

External ESHS Audits are to be conducted by the external agencies that are competent with ISO qualified auditors having requisite experience with the prior approval of the Engineer.

a) Areas of Competence of Audit Team

i) The Audit team shall have practical understanding of BOCW Act and Rules, statutory requirements on health/medical and welfare of workmen, construction hazards and its prevention and control, traffic management, electrical safety, rigging, safety of construction equipment and environment and social management.

ii) Audit shall be conducted as per the guidelines of ISO, ILO and national standards. Audit report shall also be presented as per the formats given in the standards; and

iii) External ESHS Audit shall be conducted on a quarterly basis throughout the currency of the Contract.

b) Targets of ESHS Audit:

The contents and coverage of the audit shall include the following items:

i) ESHS Management:

- ESHS Organization;
- ESHS Policy and Plan;
- ESHS committee;
- ESHS orientation;
- ESHS training;
- ESHS communication and motivation;
- ESHS submittals to the Employer;
- ESHS promotional and awareness program;
- Incident reporting &investigation;
- Onsite/offsite emergency preparedness plan;
- Hazard identification and risk assessment;
- Implementations of work permit system.

ii) Technical:

- Work Method Statement;
- Operational control procedures/ Safe operating procedures;
- Working at height;
- Hand tools and power tools;

- Electrical safety;
- Fire prevention and control;
- Housekeeping;
- Overhead protection;
- Slipping, tripping, cutting, drowning and falling hazards;
- Lifting appliances and gear, tools and tackles;
- Lifting and launching operation;
- Construction plant and machinery;
- Machine and area guarding;
- Material handling;
- Hot work;
- Demolition;
- Excavation and tunnelling;
- Work permit system;
- Traffic management;
- Chemical handling;
- Dangerous and harmful Environments;
- Maintenance matrix of mechanical and electrical machines / equipment;
- Working on or under water;
- Working near or under high tension line;
- Personal protective equipment;
- Visitors at site;
- Occupational health and welfare measures;
- All statutory forms, returns under various statutes;
- First-aid and medical facilities;
- Welfare measures; and
- Environmental and Social management.

c) Audit Documents:

The Contractor shall make the below itemized documents available for review by the Audit team;

a) ESHS Policy;
a) ESHS Management Manual;
b) ESHS Rules and Regulation;
c) ESHS Organization chart;
d) Annual ESHS objectives/programs;
e) Accident/near miss statistics and analysis;
f) ESHS training program/records for all personnel;
g) Operating manuals and maintenance manual of all equipment;

h) Safe worthiness certificates of all lifting appliances and gears;
i) Medical fitness record for all personnel;
j) Risk identification, assessment and control details;
k) Environmental and Social management reports;
l) Emergency management records including mock drill;
m) Housekeeping inspection records;
n) Minutes of ESHS committee meetings;
o) Calibration and testing records;
p) Safety budgets;
q) Records of previous audits;
r) Safety inspection records;
s) First Aid, medical facilities and other welfares measures;
t) Maintenance procedure of plant &machinery;
u) Records of Industrial hygiene surveys (noise, ventilation, and illumination level, airborne and toxic substances, explosive gases).

d) Reporting

Audit report shall be prepared and directly sent to the Engineer within 7 days of conducting the audit with a copy to the contractor.

e) Report Contents:

a) Executing Summary - Based on the finalized checklists as written the findings tothe Engineer by the audit team members, the audit leader will compile a conciseand accurate summary of observations and findings;
b) Introduction- This will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation andpost-audit activities);
c) Principal Positive Findings - This will contain the summary of positive aspects as observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or achievement;
d) Audit Findings - All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing:
   i. Priority 1: Actions to rectify gaps or weakness should generally be implemented within two-weeks' time if risk potential is high or unacceptable; and
   ii. Priority 2: Actions should be generally implemented or rectified with a maximum of 3- 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

f) Conformity Report Action to the Engineer:

a) The auditor shall inspect the site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer with a copy to the contractor;
b) The auditor shall again inspect after 28 days of conducting initial audit for checkingthe adequacy of implementation of items mentioned under priority 2 by

the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer with a copy to the contractor; and

c) In case of non-conformity of items mentioned by auditor, the Engineer shall take necessary steps including stoppage of work and or imposing any penalty for gettingthe item implemented.

d) If the Contractor fails to conduct the External ESHS Audit in time, the Engineer shall get it done. All expenses related to the external ESHS audits shall be borne bythe Contractor.

2.13. ESHS Communication

2.13.1. The Contractor shall make every effort to communicate the ESHS Management measures through posters campaigns/billboards/banners/glow signs being displayed around the site as part of the effort to raise ESHS awareness amongst the work force. Posters should be in Hindi, English and other suitable language deemed appropriate. Posters/billboards/ banners/glow signs should be changed at least once in a month to maintain the impact.

2.13.2. The Contractor shall also observe important days as listed in Attachment-4[General Instruction: ESHS/GI/006] and printing and displaying safety signage and posters as listed in Attachment-4[General Instruction: ESHS/GI/007].

2.14. ESHS Submittals

2.14.1. The Contractor's ESHS Management shall send the following reports to the Engineer periodically in soft copy:

a) Daily reporting of total number of workmen;

b) Monthly ESHS Reports;

c) Minutes of ESHS Committee meeting;

d) ESHS inspection and compliance reports; and

e) ESHS audits reports;

- Monthly Audit Rating Score (MARS) reports;
- Monthly Electrical Safety Audit;
- External ESHS audits;

2.14.2. The Contractor shall prepare a Monthly ESHS Report consisting of the following within 7th of next month to the Engineer:

a) Monthly man-hour details as specified in the ESHS Management Plan;

b) Monthly accident/incident details as specified in the ESHS Management Plan;

c) ESHS committee details;

d) ESHS inspection and compliance report;

e) ESHS internal audit details.;

f) ESHS communication activities undertaken in the month indicating the number of posters displayed and balance availability in stock;

g) Monthly Environment (including air, noise, water and soil testing results) and Social Report;

h) Graphical representation of monitored results over past four reporting periods;

i) Details of interactions with regulators (e.g. Pollution Control Board, Forest Department etc.) including dates, subjects, outcomes (report the negative if none);

j) Details of Clearance/ Permission//Permit obtained;

k) Compliance status for conditions of all relevant clearances /permissions / consents/permits for the Work, including quarries, etc.;

l) Tree felling, transplanting and compensatory planation details;

m) Details of consumption of construction material, energy and water;

n) Details of different types of waste and scrap generated during the month and sold to authorised recyclers;

o) Summary of complaints, results of investigations and follow-up actions;

p) Gender: Number of female workers, percentage of female workforce, gender issue raised and dealt with;

q) HIV/AIDS: Provider of health services, information& training;

r) GBV/SEA: Details of training conducted;

s) Grievances: List of grievances received in the reporting period and unresolved past grievances by date received, complaint how received, to whom referred to for action, resolution and date (if completed), date of resolution of community grievances if any.

t) Toolbox talks details;

u) PPE details: Quantity purchased, issued to the workmen and stock available;

v) Details on IP 44 panel boards, lighting poles, welding and cutting equipment, Ladders, Hoists, Tools & Tackles;

w) Monthly lux meter study results;

x) Housekeeping;

y) Barricade maintenance details;

z) No of critical excavations;

aa) Health and welfare activities;

bb) ESHS activities planned for next month.

Formats in which information to be given for monthly Environment and Social aspectsare given in Attachment 4 [General Instruction: ESHS/GI/008]

2.15. Accident Reporting and Investigation

2.15.1. All accidents and dangerous occurrences shall immediately be informed through message to the Engineer and the Employer. AIIB is to be informed within two days of the event. This will enable the Engineer to reach to the scene of accident/dangerous occurrences to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

2.15.2. Reports of all accidents (fatal/injury) and dangerous occurrences shall also be sent within 24 hours by the Contractor.

2.15.3. No accident/dangerous occurrences are exempted from reporting to the Employer.

2.15.4. Any wilful delay in verbal and written reporting to the Employer and Engineer shall be penalized as per Clause 7. [Financial Deduction/Withholding].

2.15.5. In addition to the above verbal and written reporting to the Employer and Engineer, as per Rule 276 of HBOCWR, notice of any accident to a worker at the site that:

a) Causes loss of life; or;

b) Disables a worker from working for a period of 48 hours or more immediately following the accident; shall forthwith be sent by telegram, telephone, fax, or similar other means including special messenger within 4 hours in case of fatal accidents and 72 hours in case of other accidents, to:

i) The Assistant Director, Industrial Safety and Health having jurisdiction in the area in which the establishment in which such accident or dangerous occurrence took place is located. The Assistant Director, Industrial Safety and Health shall be the authority appointed under section 39 of the Act;

ii) Board with which the building worker involved in accident was registered as a beneficiary;

iii) Chief inspector; and

iv) The next of kin or other relative of the Worker involved in the accident.

2.15.6. Further, notice of any accident shall be sent in respect of an accident which:

a) Causes loss of life; or;

b) Disables the injured worker from work (for a period of more than 10 days) to;

i) The Officer-in-charge of the nearest police station;

ii) The District Magistrate or, if the District Magistrate by order so desires to;

iii) The Sub-Divisional Magistrate.

2.15.7. In case of an accident-causing minor injury, first-aid shall be administered, and the injured worker shall be immediately transferred to a hospital or other place for medical treatment.

2.15.8. Where any accident-causing disablement that subsequently results in death, notice in writing of such death, shall be sent to the authorities within 72 hours of such death.

2.15.9. The following classes of dangerous occurrences shall be reported to the inspector having jurisdiction, whether any disablement or death caused to the Worker, namely:

a) Collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage orfailure of rope, chain or loose gears; or overturning of cranes used in construction work;

b) Falling of objects from height;

c) Collapse or subsidence of soil, tunnel, pipelines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork;

d) Explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure of any gas or any liquid or solid used as building material;

e) Fire and explosion causing damage to any place on the site where the Workers are employed;

f) Spillage or leakage of any hazardous substance and damage to their container;

g) Collapse, capsizing, toppling or collision of transport equipment; and

h) Leakage or release of harmful toxic gases at the site.

2.15.10. In case of failure of launching girder, lifting appliance, loose gear, hoist machinery and transport equipment at the site, such appliances, gear, hoist, machinery or equipment and the site of such occurrence shall, as far as practicable, be kept undisturbed until inspected by the authorities.

2.15.11. Every notice given for fatal accidents or dangerous occurrences shall be followed by a written report to the concerned Authorities under Section 39 of BOCWA and the Chief Inspector of Government of Haryana in the specified Form **XLVI** of the **HBOCWR.**

2.15.12. Actions to be taken post incident/accident:

a) In case any incident/accident happens at site leading to injury to the worker,the worker/s is/are required to be taken to the nearest hospital immediately;

b) Project Manager/ESHS Manager/Labour Welfare Officer of the Contractor

c) needs to report the incident to the Engineer immediately without fail for all the death cases including natural deaths;

d) In case of fatal accident, doctor from the nominated hospital is the only authorized person to declare the death of the worker. It is not to be decided suo-moto by any other person. FIR should be registered for all the fatal cases which happen at the site/labour camp;

e) Post Mortem of the dead body is mandatory in all the death cases i.e. whether it is natural or due to any incident / accident;

f) Family members of the injured / deceased worker are to be informed immediately;

g) In case of fatal accident, the dead body is to be handed over to the family members. Arrangement of sending the dead body to the native place shall be made by the contractor including cash payment for meeting out last rites expenses as per Rules;

h) Fatal accident report is to be sent to State Labour Authority in Form EE (as per workmen's compensations act) within seven days and to the Licensing Authority in Form XLVI within 24 hours of the incident/accident;

i) Workmen's Compensation dues are to be deposited with the Employee's Compensation Commissioner within 30 days of the death or the period of notice served by the Employee's Compensation Commissioner;

j) Copy of all the documents deposited with any labour authority, FIR, Post Mortem, Medical Reports etc. shall be submitted to the Engineer in duly approved Labour Welfare Fund (LWF) Form;

k) The Contractor shall be liable for getting disbursement of Provident Fund benefits, compensation under Employee compensation Act, benefits of ESI Act to the workman/dependents of the deceased workman. The Contractor shall also provide accommodation and transportation to dependents of the deceased workman or to the disabled workman who come for settlement ofterminal claims.

2.15.13. **Accident Investigation:**

a) Investigations shall be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences;

b) Accidents and dangerous occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence; and

c) Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the ESHS Management System.

2.15.14. Procedure of Incident Investigation

It is important after any accident or dangerous occurrence that information relating to the incident is gathered in an organized way. The following steps shall be followed:

a) Take photographs and make sketches;

b) Examine involved equipment, work piece or material and the environmentalconditions;

c) Interview the injured, eye-witnesses and other involved parties;

d) Consult expert opinion where necessary; and

e) Identify the specific Contractor or subcontractor involved.

2.15.15. Having gathered information, it is then necessary to make an analysis of incident:

a) Establish the chain of events leading to the accident or incident;

b) Find out at what stage the accident took place;

c) Considering all possible causes and the interaction of different factors that led up to the accident and identify the most probable cause, the cause of an accident should never be classified as carelessness; and

d) The specific act or omission that caused the accident must be identified.

2.15.16. The next stage is to proceed with the follow-up action:

a) Report on the findings and conclusions;

b) Formulate preventive measures to avoid recurrence; and

c) Publicize the findings and the remedial actions taken.

2.15.17. The Engineer's Independent Incident Investigation

In case of fatal/dangerous occurrence, the Engineer shall also conduct independent investigation. The Contractor and his staff shall extend necessary co-operation and testify about the accident.

2.15.18. The Contractor shall take every effort to preserve the scene of accident till the Engineer completes the investigation.

2.15.19. All persons summoned by the Engineer in connection to witness recording shall obey the instructions without delay. Any wilful suppression of information by any person shall be removed from the site immediately and/or punished as per Clause 7. [Financial Deduction/Withholding].

2.16. Emergency Preparedness Plan

2.16.1. The Contractor shall prepare as required under BOCWR, an Emergency Response Plan for the site as a part of the Contractor ESHS Management Plan. The plan shall integrate the emergency response plans of the Contractor and all other Subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communication arrangements, for dealing with all emergencies that could affect the site. The plan shall address items such as injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

2.16.2. The Contractor shall ensure that the Emergency Response Plan is prepared to deal with emergencies arising out of, but not limited to:

a) Fire and explosion;

b) Collapse of lifting appliances and transport equipment.

c) Collapse of building, sheds or structure etc.

d) Gas leakage or spillage of dangerous goods or chemicals;

e) Bomb threatening, Criminal or Terrorist attack;

f) Drowning of workers; and

g) Landslides getting workers buried, floods, earthquake, storms and other natural calamities etc.

The above list is not exhaustive and other emergencies can also be included.

2.16.3. Arrangement shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the Contractor with their telephone numbers and addresses for quick communication shall be adequately publicized and conspicuously displayed in the workplace.

2.16.4. The Contractor shall require to tie-up with the hospitals and fire stations located in the neighbourhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.

2.16.5. The Contractor shall conduct an onsite emergency mock drill once in every month for all his workers and his sub-Contractor's workers.

2.16.6. It shall be the responsibility of the Contractor to keep the Local Law and Order Authorities informed and seek urgent help to mitigate the consequences of an emergency. Prompt communication to the Employer and Engineer, through telephonically initially and followed by a written report, shall be made by the Contractor.

2.17. Experts/Agencies for Environment, Social, Health & Safety Services

2.17.1. The Contractors may utilise the services of experts/agencies empanelled for the purpose of training, audit and any other ESHS services with prior approval of the Engineer. This approval can be withdrawn by the Engineer at any time if the quality of output of the agency is found not satisfactory.

3. LABOUR PROTECTION

3.1. General

3.1.1. The Contractor shall comply in full of the project Workplace Policy as described in Attachment-2 [Work Place Policy on HIV/AIDS, Prevention & Control] and Attachment -3 [Covid 19 policy].

3.2. Engagement of Staff and Labour

3.2.1. The Contractor shall ensure that the employees deployed by him in the premises of the Employer are physically and mentally fit and do not have any criminal record.

3.3. Payment of Minimum Wages

3.3.1. The Contractor shall ensure payment of at least the minimum wages as prescribed and applicable from time to time under the Minimum Wages Act, 1948 in the presence of an authorised representative of the Engineer and shall maintain proper records of their timely disbursement. These records shall be preserved for a period of at least 3 years and made available even after the Contract is over for any verification by the statutory authorities.

3.4. Conditions of Labour

3.4.1. The Contractor shall observe conditions of labour that are no less favourable than those established for the relevant trade or industry.

3.4.2. During the work, the Contractor shall afford all employees all basic rights enumerated in the conventions of the International Labour Organisation, including freedom of association, right to freedom from forced labour, and right to freedom from discrimination based on race, colour, sex, religion, political opinion and social origin.

3.4.3. The Contractor shall ensure coverage of his employees under the Employees Provident Fund and Miscellaneous Provisions Act, 1952 and the Employees State Insurance Act, 1948 via independent code numbers allotted to them by the Central Provident Fund Organisation and Employees State Insurance Corporation respectively.

3.4.4. The Contractor shall insure all his employees under Group Personal Accident Insurance scheme through a recognised and registered insurance company.

3.5. Labour Laws

3.5.1. The Contractor shall ensure that all his employees and the Subcontractors obey applicable following laws and regulations, including those concerning safety at work.

a) Minimum Wages Act, 1948;
b) Payment of Wages Act, 1936;
c) Equal Remuneration Act, 1976;
d) Employees Provident Fund and Miscellaneous Provisions Act, 1952;
e) Payment of Gratuity Act, 1972;
f) Employees State Insurance Act, 1948;
g) Payment of Bonus Act, 1965;
h) Maternity Benefit Act, 1951;
i) Industrial Disputes Act, 1947;
j) Trade Unions Act, 1926;

k) Child Labour (Prohibition and Regulation) Act, 1986;

l) Building and Other Construction Workers (Regulation of Employment of Service) Act, 1996;

m) Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005;

n) Building and Other Construction Workers Welfare Cess Act, 1996;

o) Building and Other Construction Workers Welfare Cess Rules, 1998;

p) The Contract Labour (Regulation and Abolition) Act, 1970 and Rules,1971;

q) Inter State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979;

r) Haryana Major Accident, Hazard Control Rules, 2009;

s) Workmen's Compensation Act. 1923;

t) Factories Act, 1948;

u) Mines Act, 1952.

3.5.2. The Contractor shall comply with all other statutory requirements, rules, regulations and notifications in relation to employment of his staff and workers that may be issued from time to time by the concerned government authorities.

3.6. Working Hours

3.6.1. No work shall be carried out beyond the statutory limit given under BOCWA, 1996.

3.6.2. No work shall be carried out outside the normal working hours stated in the Contract unless otherwise:

a) The Engineer gives his consent in writing for additional work; and

b) The work is unavoidable or necessary for the protection of life or property or forthe safety of the Works, in which case the Contractor shall immediately inform the Engineer.

4. SAFETY GENERAL

4.1. General

4.1.1. The following standards whichever is more stringent shall be applicable:

a) The BOCW Acts 1996, and the Haryana BOCW Rules 2005 framed there under;

b) Other relevant National Legislations & IS Codes.

4.2. Housekeeping

4.2.1. General Housekeeping shall be carried out by the Contractor and ensured always at the site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and Toilets/Urinals.

4.2.2. Full height fence, barriers, barricades etc. shall be erected around the site to prevent the surrounding from excavated soil, rubbish etc., which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Engineer. These shall be maintained in one line and level.

4.2.3. The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to housekeeping. All surplus earth and debris are removed/disposed of from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists

4.2.4. Water logging or bentonite/polymer spillage on roads shall not be allowed. If bentonite/polymer spillage is observed on road endangering the safety of road users, the Contractor shall be penalized as per Clause 7. [Financial Deduction/Withholding].

4.2.5. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

4.2.6. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

4.2.7. Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored/stacked in an orderly and safe manner. Lumber with protruding nails shall be bent/removed and properly stacked.

4.3. Working at Height

4.3.1. Working at height means work in any place, including a place at or below ground level.

4.3.2. The Contractor shall ensure that work at height is properly planned, appropriately supervised, and carried out in a safe manner and without any appreciable risk. Appropriate care shall be taken during bad weather.

4.3.3. Adequate protection in the form of working platform with railing, toe board, safe access, safety net, roof ladder etc. shall be provided. Where fall hazards cannot be eliminated, use fall-arrest systems while erecting, modifying, and dismantling scaffolds.

4.3.4. A trained and certified person shall check working platform, railing, toe board, safe access, safety net, roof ladder etc. after erection and once in a week. A certificate shall be tagged on this equipment.

4.3.5. Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding and also workers who perform work on a scaffold shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work.

4.3.6. When the height of a scaffold exceeds three times of the smallest width of the base, secure it to the building or structure at every other lift and every 9.0 m horizontally. The scaffold and scaffold working platform with handrails approximately 1.0 m high, mid rails, and toe boards, all secured rigidly by both ties and braces to prevent movement. Working platforms should be completely decked with safety planks, manufactured scaffold decking, or metallic planks.

4.3.7. Only metal frame working scaffold is permitted. Steel stairs are used as a means of raising and lowering the metal frame working scaffold, except for special cases. It is prohibited to directly raise and lower the framework with limbs or to use only ladder.

4.3.8. The Contractor shall ensure that following areas are clearly indicated:

a) where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work;

b) Falling a distance; or

c) Being struck by a falling object:

4.3.9. The Contractor shall ensure that work equipment exposed to conditions causing deterioration, which is liable to result in dangerous situations, is inspected at suitable intervals and after any exception occurrence jeopardizing the safety of work/equipment.

4.3.10. In relation to work at height involved in construction work;

a) The top guard-rail or other similar means of protection shall be at least 1100 mm above the edge from which any person is liable to fall;

b) Toe-boards shall be suitable and sufficient to prevent the fall of any person, or any material or object, from any place of work; and

c) Any intermediate guardrail or similar means of protection shall be positioned sothat any gap between it and other means of protection does not exceed 550 mm.

4.3.11. Requirements for all Working Platforms:

a) Every working platform requires a firm & stable supporting structure for holding it;

b) A working platform shall possess a suitable surface and be so constructed that the surface of the working platform has no gap through which a person/material/object could fall;

c) A working platform and any supporting structure shall not be loaded to give rise to a risk of collapse or to any deformation, which could affect its safe use;

d) When altered or modified, it should be so altered or modified as to ensure that it

e) remains stable;

f) A working platform shall be of sufficient dimension to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work being carried out there;

g) Depending on the complexity of the scaffolding selected, a responsible person shall draw up an assembly, use and dismantling plan;

h) A copy of the plan, including any instructions it may contain, shall be kept available for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until it has been dismantled; and

i) While a scaffold is not available for use, including during its assembly, dismantling or alteration, it shall be marked with general warning signs in accordance with and be suitably delineated by physical means preventing access to the danger zone.

4.3.12. Requirements for collective safeguards for arresting falls:

a) Collective safeguard is a safety net, airbag or other collective safeguard for arresting falls;

b) A safeguard shall be used only if:

   i) A risk assessment has demonstrated that the work activity can (so far as is reasonably practicable) be performed safely while using it and without affecting its effectiveness;

   ii) The use of other safer work equipment is not reasonably practicable; and

   iii) A sufficient number of available persons have received adequate training specific to the safeguard, including rescue procedures.

4.3.13. Requirements for personal fall protection systems:

a) A personal fall protection system shall be used only if a risk assessment hasdemonstrated that;

   i) The work can (so far as be reasonably practicable) be performed safely while using that system; and

   ii) The use of other safer work equipment is not reasonably practicable.

   The user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures; and

b) A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability to supporting any foreseeable loading.

4.3.14. Requirements for Ladders:

a) Every Contractor shall ensure that a ladder is used for work at height only if a risk assessment has demonstrated that the use of more suitable work equipment is not justified because of the low risk;

   i) The short duration of use; or

   ii) Existing features on the site, which he cannot alter.

b) Only metal ladders shall be allowed. Bamboo ladders are prohibited;

c) Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it;

d) A ladder shall be so positioned as to ensure its stability during use;

e) A suspended ladder shall be attached in a secure manner and so that, with the exception of a flexible ladder, it cannot be displaced and swinging is prevented.

f) A portable ladder shall be prevented from slipping during use by-

   i) securing the stiles at or near their upper or lower ends;

   ii) an effective anti-slip or other effective stability device; or

   iii) any other arrangement of equivalent effectiveness.

g) A ladder used for access shall be long enough to protrude sufficiently above the place of landing to which it provides access, unless other measures have been taken to ensure a firm handhold;

h) No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use;

i) A mobile ladder shall be prevented from moving before it is stepped on.

j) Where a ladder or run of ladders raises a vertical distance of 9.0 m or more above its base, there shall, where reasonably practicable, be provided at suitable intervals sufficient safe landing areas or rest platforms;

k) Every Ladder shall be used in such a way that

i) A secure handhold and secure support are always available to the user; and

ii) The user can maintain a safe handhold when carrying a load unless, in the case of a step ladder, the maintenance of a handhold is not practicable when a load is carried, and a risk assessment has demonstrated that the use of a stepladder is justified because of

A. The low risk; and

B. The short duration of use.

4.4. Overhead Protection

4.4.1. All contractors shall provide overhead protections as per BOCW Act & Haryana BOCW Rules.

4.5. Slipping, Tripping, Cutting, and Falling Hazards

As Per Rule 98 of HBOCWR:

a) All places should be free from dust, debris or similar materials;

b) Sharp projections or any protruding nails or similar objects shall be suitably guarded or shall even be avoided to make the place safe to work;

c) Contractor shall not allow workmen to work or use platforms, scaffolds/passageways or any walkways, which has water, or oil or similar substances spilt and has a slipping hazard, unless it is cleaned off or covered or sanded or saw dusted or make it safe with any suitable material;

d) Open side or opening where worker, equipment, vehicle or lifting appliance may fall at a building or outside shall be guarded suitably except in places of free access by reasons of nature of work;

e) Suitable safety net shall be provided at places of material / man falling is possible in accordance with national standards.

f) Reinforcement of pier/columns/walls/abutments shall be secured from the risk of tilting through provisioning of minimum four guy wires ropes/ steel bracing anchored to any concrete block/counterweight of sufficient capacity.

4.6. Lifting Appliances including Cranes

4.6.1. Lifting appliances means a crane, hoist hydra, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, slewing bearing fasteners, lifting machinery sheaves, pulley blocks, hooks or other equipment used for lifting materials, objects or the Workers and lifting gears means ropes, chain slings, shackles, hooks, lifting lugs, wire ropes, lifting eyebolts and eye nuts and other accessories of a lifting appliance.

4.6.2. Each of the lifting appliances and lifting gear including all parts thereof, whether fixed or moveable shall be thoroughly tested and examined by a competent person once at least in every 6 months or after it has undergone any alterations or repairs liable to affect its strength or stability. Within the validity, if the lifting appliances are shifted to a new site, re-examination by the competent person for ensuring its safety shall also be done.

4.6.3. The Contractors shall utilize the services of any competent person as defined in Factories Act, 1948 with the permission of the Engineer.

4.6.4. No machine shall be selected to do any lifting on a specific job until its size and characteristics are considered adequate:

a) The weights, dimensions and lift radii of the heaviest and largest loads;

b) The maximum lift height, the maximum lift radius and the weight of the loads that must be handled at each;

c) The number and frequency of lifts to be made;

d) How long the crane will be required on site;

e) The type of lifting to be done (for example, is precision placement of loads important;

f) The type of carrier required (this depends on ground conditions and machine capacity In its operating quadrants: capacity is normally greatest over the rear, less over the side, and non-existent over the front;

g) Whether loads will have to be walked or carried;

h) Whether loads will have to be suspended for lengthy periods;

i) The site conditions, including the ground where the machine will be set up, access roads and ramps it must travel, space for erection and any obstacles that might impede access or operation.

4.6.5. The Contractor shall ensure that a valid certificate of fitness issued is available for all lifting appliances including synchronized mobile jacks, pre-stressing hydraulic jacks, jacks fitted with launching girders etc. and the Engineer approval is obtained before inducting to the site. Only after obtaining the approval from the Engineer any lifting appliances and gear shall be used.

4.6.6. The laminated photocopies of fitness certificate issued by competent person, the Engineers approval letter, the operators photo, manufactures load chart and competency certificate shall always be either kept in the operator cabin or pasted on the visible surface of the lifting appliances.

4.6.7. All lifting appliances and loose gears shall be clearly marked for its safe working load and identification by stamping or other suitable means.

4.6.8. The Contractor shall also maintain a register containing a system of identification of all tools and tackles, its date of purchase, safe working load, competent person date of examination etc.

4.6.9. Sufficient lighting arrangement shall be ensured at all lifting operations.

4.6.10. **Qualification of operator of lifting appliances etc.:** The Contractor shall not employ any person to drive or operate a lifting machine-like crane, hydra etc. whether driven by mechanical power or otherwise or to give signals to work as an operator of a rigger or derricks unless he:

a) Is above 21 years of age and possesses a valid heavy transport vehicle driving license as per Motor Vehicle Act and Rules;

b) Is competent and reliable;

c) Possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance acceptable to the Engineer; and

d) Is medically examined periodically as specified in schedule VII of BOCW Rules.

4.6.11. All hydraulic piping and fittings shall be maintained leak proof.

4.6.12. Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting.

4.6.13. Hand spliced slings up to 32mm diameter shall not be used at site for any lifting purpose. The slings used shall confirm to IS 2762: 2009 Wire rope slings and sling leg specification.

4.6.14. No load shall be slewed over public areas without stopping the road traffic first.

4.6.15. Failure to do any of the above shall attract penalty from the Employer as per Clause 7. [Financial Deduction/Withholding].

4.6.16. Automatic safe load indicator (ASLI) to be provided in crane with audible and visible warning system and made functional and calibrated by the manufacturer or its authorized representative every 6 months or after repair of the lifting equipment.

4.6.17. **Automatic safe load indicators and data logger in lifting appliances**

As stipulated in Rule 123 of HBOCW Rules, every lifting appliances and gears like cranes, hydras etc., if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise, shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/International certifying bodies which gives a warning to the operator whenever the load being handled exceeds the safe working limit.

a) Provision of functional data logger with alert facility through SMS and web in all cranes shall be mandatory;

b) Cut-out shall be provided which automatically arrests the movements of thelifting parts of every crane if the load exceeds the safe working limit.

4.6.18. The crane should have a substantial/durable safe working load chart which has clearly legible characters in English and Hindi and figures displayed inside the crane and is easily visible to the crane operator.

4.6.19. General Requirements

The sweep area (work area) of the construction machinery shall be always free from obstructions. All hydraulic piping and fittings shall be maintained leak proof. The operator cab shall posses good and safe:

a) Structure, windows and windshield wipers;

b) Drivers chair and footrest;

c) Control handles;

d) Cab instrumentation;

e) Telecommunication;

f) Cab outfitting;

g) Wind indicator with an adjustable set point shall be in a position representative for the wind on the crane. The indicator shall give continuous information regarding constant speeds and gusts.

4.6.20. Mandatory Rigging requirement

a) Rigging shall be done under experienced and qualified rigger only. All Load shall be adequately and safely rigged to prevent any danger;

b) The primary requirement in rigging shall be to assess the weight of load before attempting any lift;

c) All hooks shall be fitted with Master Rings having certificate of fitness from the competent person, so that the hooks are subjected to balanced vertical loading only;

d) Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting;

e) Requirements of outriggers

i) All outriggers shall be fully extended and at all tyres are clear of theground;

ii) Heavy duty blocking having large bearing area shall be necessary to prevent sinking of floats;

iii) Provision of heavy steel plates/ high density interconnected wooden logs of required dimension shall be used to uniformly distribute the load;

iv) The crane shall be setup on fully compacted ground;

4.6.21. Pick & carry operation

Prohibition on Use of "Tractor transmission type Pick and Carry Hydra Crane": Tractor transmission type Pick and Carry-1st Generation model is prohibited at HRIDC works. Contractor shall mobilize "Truck transmission type" Pick and Carry (Hydra)Crane– minimum 2nd Generation model only or higher model.

Pick and Carry operation is prohibited at all HRIDC construction sites except for the tailing purpose for lowering of pile cage, erection of radio tower, electrical poles, exhaust structures etc.

4.6.22. Operation of lifting appliances

Every Contractor shall ensure that:

a) The complete lifting operation shall be governed by signals as per established standards;

b) Adequate measures to be taken to ensure that no workers is allowed to stand, pass, rides or sit under the suspended load;

c) No lifting appliances shall be left by the operator while power is on or load is suspended;

d) After completion of the lifting operation, all doors of the appliances shall be closed by the operator and ignition/operation key should be handed over to competent reliever operator or site In-charge;

e) All loads are provided with minimum two tag lines to ensure that the load can be controlled at all times;

f) No close working to any live over head power line is permitted without system of a 'Permit to Work' and prior permission of the engineer shall be obtained before performing such operation;

g) Danger zone shall be identified and cordoned off for all lifting appliances during their operation;

h) All lifting gears & slings shall be stamped or appropriate tags for their identification no & SWL;

i) Knotting/wrapping of chains & slings shall not be allowed at site;

j) Lifting appliances shall not be used for any dragging or pulling purposes. Contract shall refer to 75% capacity load chart for ascertaining the suitability of crane for safe lifting of load;

k) During tandem lift, available capacity of crane in respect of SWL shall be considered after reduction of 15% for 75% (DIN) load chart respectively. In addition, additional de rating as advised by third party testing and certified agency shall also apply;

l) During hoisting of long material, use of suitable lifting beam is recommended;

m) Only original equipment manufacturer (OEM) supplied/provided load chart shall be used during lifting operation;

n) Before performing any lifting operation, all electronic devices, control levers, hydraulic oil, wind pressure etc. shall be checked and necessary spare parts to be kept in stock to handle any breakdown during time bound lifting operation;

o) Lifting point shall be considered on the I-Girders/U Girder/C Girder/Steel girder/parapet etc. during the casting of the same. Design load calculation for the same should be conducted;

p) All lifting activities shall be stopped in case of high speed wind and similar adverse whether condition or as prescribed by the crane manufacturer; and

q) All cranes shall be provided with fail safe devices to avoid any hoist free fall in case of brake failure.

4.7. Launching Operation

4.7.1. As launching operation is one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing casing yard, casting segments, transporting segments, fabrication and erection of launching girders, launching of segments, pre-stressing, auto launching of girders and dismantling of launching girders.

4.7.2. The Contractor shall prepare a comprehensive Method Statement for the launching operation, adhering to the ESHS conditions laid down in conditions of contract on the ESHS Management Manual. Reference shall be made to the provisions on working at height. As the entire process of launching must be undertaken at an elevated level the safety of workers and the girder is paramount important. In addition to general precautions, such as trained personnel, PPE, etc. listed in earlier clauses, the following general guidelines shall be adhered to throughout the launching operation:

a) The segments shall rigidly secure to the truck with necessary wooden wedges and necessary red indicators/safety tapes provided so that the vehicle is clearly seen by other road users both in day/night time;

b) Every launching operation shall have a responsible engineer on duty all the time;

c) All the time from erection to dismantling the area between the two piers wherein launching is in progress shall always be barricaded;

d) Auto launching shall be done only after approval from the Engineer. After every auto launching the stability of launching girder shall be ensured;

e) The vertical deflection of launching girder shall be monitored at all critical stages like with/without loads and after every auto launching;

f) A register containing all important operational details from erection to dismantling of launching girders shall be maintained and made available to the Engineer whenever called for;

g) Driver shall also have undergone proper medical examination as per sub-Clause-5.2 (Medical Facilities) and checked for influence of alcohol before any kind of lifting operation;

h) Test certificate for all lifting gears including Macalloy Bars shall be maintained at a

i) location closer to the launching girder itself so that it can be referred during all inspections;

j) Proper & safe access stairways shall be maintained for safe ascending /descending of workmen /engineers to or from launchers;

k) Adequate collective and personnel fall protection measures like provision of safety nets while working over live roads/railways, lifeline for anchoring of safety harness, safe means of access on main box girder shall be ensured;

l) Before starting of the launching, valid third party test certificate of the launcher hoist shall be available;

m) Safe and fully deck working platform duly covered from all side shall be ensured for stressing work at front support;

n) Safety checklist for all activities of launching cycle shall be prepared, got approved & implemented;

o) Use of nonstandard locking pins shall attract penalty;

4.8. Construction Machinery

4.8.1. Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers, piling rigs, vibration hammers, rail welding equipment, mobile elevating work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, locomotives, tankers and bowsers, trailers, hydraulic and mechanical breakers etc.

4.8.2. Every construction equipment shall be in sound mechanical working condition and certified by either competent person under Factories Act or manufacturers' warranty in case of brand new equipment or authorized persons/firms approved by the Engineer before induction to any site.

4.8.3. Fitness of the machine shall be carried out on regular basis or after every maintenance work excluding any minor service/oil or filter change and be documented properly. The certificate shall be available in operator/driver cabin.

4.8.4. All vehicles shall be fitted with audible reverse alarms and maintained in good working condition. Reversing shall be done only when there is adequate rear-view visibility or under the directions of a banksman.

4.8.5. **General operating procedures:** Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

a) No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturer's recommendations;

b) Working on gradients beyond any equipment's capability shall not be allowed.

c) Prevention of dumper and dump truck accidents should be managed by providing for adequate lateral clearances, wheel stops at a sufficient distance from the edges of excavations, spoil heaps, pits, markers, etc.;

d) No construction material, other than soil shall be carried in excavator buckets;

e) When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them;

f) Every contractor shall ensure that Competency certificate for driver/operatorsshall be issued by their Plant and Machinery In-charge. The certificate shall be pasted on the machine body in such a way that drivers/operator vision is nothindered;

g) Checklist shall be prepared for all construction machinery and be filled on daily basis by the operator and be counter signed by plant & machinery person;

h) Provision of helper is mandatory for each construction appliances and vehicles during their movement inside and outside of site; and

i) All wood working machines shall be fitted with suitable guards and devices such astop guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator.

4.8.6. Failure to do any of the above shall attract penalty as per Clause 7. [Financial Deduction/Withholding].

4.9. Machine Guarding

4.9.1. The Contractor shall ensure at the site all motors, cog wheels, chains and friction gearing, fly wheels, shafting, dangerous and moving parts of machinery are securely fenced or legged.

4.9.2. Fencing of dangerous parts of machinery shall not be removed while the machinery is in use or in motion and when removed, it shall be replaced as soon as practicable and in any case before the machinery is again brought into use.

4.10. Site Electricity

4.10.1. The Contractor shall refer to the applicable guideline "Indian Electricity Rules, 1956" and any amendment thereafter. ESHS requirements are:

a) Graduate Electrical Engineer having Electrical Supervisory Competency Certificate.

b) Diploma Electrical Engineer having Electrical Supervisory Competency

Certificate;

c) ITI Certificate Holder Electrician with Wiremen Permit; and

d) Assessment of Electrical Load and properly designed power distribution system;

4.10.2. **Assessment of Power**

a) The contractor shall assess the size and location of the electrical loads and the manner in which they vary with time during the currency of the contract.

b) The contractor shall elaborate as to how the total supply is to be obtained/generated. The details of the source of electricity, earthing requirement, substation/panel boards, distribution system shall be prepared and necessary approval from the Engineer obtained before proceeding of the execution of the job.

c) The main contractor shall take consideration, the requirements of the Subcontractors' electric power supply and arrive at the capacity of main source of power supply from diesel generators. All the norms on installation and maintenance have to be adhered.

d) As small capacity generators create more noise and safety hazards, no small capacity diesel generators shall be allowed for whatsoever the type of job to be executed under this contract.

e) Usage of Transformers inside the tunnel is strictly prohibited.

4.10.3. **Work on site**

a) The contractor shall also submit electrical single line diagram, schematic diagram and the details of the equipment for all temporary electrical installation and these diagrams together with the temporary electrical equipment shall be submitted to the Engineer for necessary approval. Failure to do so shall invite penalty as per relevant clause.

4.10.4. No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

4.10.5. **Adverse or Hazardous Environments:**

4.10.5.1 Electrical equipment which may reasonably foreseeably be exposed to-

a) Mechanical damage.

b) The effects of the weather, natural hazards, temperature or pressure;

c) The effect of wet, dirty, dusty or corrosive conditions; or

d) Any flammable or explosive substance, including dusts, vapors or gases, shall be of such construction or an necessary protected as to prevent, so far as is reasonably practicable, danger arising from such exposure.

e) In all the above situations, only appropriate IP rated electrical panels, plug, socket etc. shall be used.

4.10.6. **Distribution System:**

a) The contractor shall provide distribution system for control and distribution of electricity from a main AC supply of 50Hz for typical appliances.

i) Fixed plant – 400 V 3 phase

ii) Movable plant fed via trailing cable over 3.75 kW – 400 3 phase.

iii) Installation in site buildings – 230V single phase.

iv) Fixed flood lighting – 230 V single phase

v) Portable and hand tools- 115V single phase

vi) Site lighting – 115V single phage

vii) Portable hand lamps – 115V single phase

4.10.7. **Electrical Protection circuits**

a) Appropriate electrical protection shall be provided for all circuits, against overload, short circuit and earth fault current.

b) The Contractor shall provide sufficient ELCBs (maintain sensitivity 30 mA)/ Residual Current Circuit Breakers (RCCBs) for all the equipment (including Potable equipment), electrical switchboards, distribution panels etc. to prevent electrical shocks to the Workers.

c) All protection devices shall be capable of interrupting the circuit without damage to any equipment's and circuits in case of any fault may occur. No single insulation cable shall be used.

d) Rating of fuses and circuit breakers used for the protection of circuits should be coordinate with equipment power ratings.

e) Protection against lighting shall be ensured through lightening arrester for equipment's kept in open at sites.

f) The contractor shall ensure that all generators and welding sets in use on site are adequately and effectively earthed at all times during operation.

4.10.8. **Cables:**

a) Cables shall be selected after full consideration of the condition to which they shall be exposed and the duties for which they are required. Supply cable up to 3.3kV shall be in accordance with BS 6346:1997;

b) For supplies to mobile or transportable equipment where operating of the equipment subjects the cable to flexing, the cable shall conform to any of these codes BS 6007/BS 6500/BS 7375.

c) Flexible cords with a conductor cross section area smaller than 1.5 mm2 shall not be used and insulated flexible cable shall conform to BS 6500 and BS 7375.

d) Where low voltage cables are to be used, reference shall be made to BS 7375. The following standards shall also be referred to particularly for underground cables BS 6346 and BS 6708.

e) Cables buried directly in the ground shall be of a type incorporating armour or metal sheath or both. Such cables shall be marked by cable covers or a suitable marking tape and be buried at a sufficient depth to avoid their being damaged by any disturbance of the ground. Cable routes shall be marked on the plans kept in the site electrical register.

f) Cable passing under the walk way and across way for transport and mobile equipment shall be laid in ducts at a minimum depth of 0.6 meters.

g) Cables that need to cross open areas, or where span of 3m or more are involved, a catenary wire on poles or other supports shall be provide for convenient means of suspension. Minimum height shall be 6m above ground.

h) Cables carrying a voltage to earth in excess of 65V other than supply for welding process shall have metal armour or sheath, which has been effectively earthed and monitored by the contractor. In case of flexible and trailing cables such earthed metal sheath and/or armour should be in addition to the earth core in the cable and shall not be used as the protective conductor.

i) Armoured cables having an over-sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.

j) Electrical cable of five cores shall be used in all three-phase equipment.

4.10.9. **Plugs, socket-outlets, and couplers:**

a) The contractor shall ensure plugs, socket-outlets, and couplers available in the construction site as splash proof type. The minimum degree of ingress protection should be of IP44 and IP65 (in Tunnels and in continuous exposures water areas) in accordance with BS EN 60529.

b) Only plugs and fittings of the weatherproof type shall be used, and they should be colour coded in accordance with the Internationally recognized standards for example as detailed as follows:

i) 110 volts: Yellow.

ii) 240 volts: Blue.

iii) 415 volts: Red.

4.10.10. **Connections:**

a) Every joint and connection in a system shall be mechanically and electrically suitable for use to prevent danger. Proper cable connectors as per national/international standards shall only be used to connect cables.

b) No loose connections or tapped joints shall be allowed anywhere in the site, office area, stores and other areas. Penalty as per Clause 7. [Financial Deduction/Withholding] shall be put in case of observation of any tapped joints.

4.10.11. **Potable and hand-held equipment:**

a) The contractor shall ensure the use of double insulated or all-insulated portable electrical hand equipment.

4.10.12. **Other equipment:**

a) All equipment shall have the provision for major switch/cut-off switch in the equipment itself.

b) All non-current carrying metal parts of electrical equipment shall be earthed through insulated cable.

c) Isolate exposed high-voltage (over 415 Volts) equipment, such as transformer banks, open switches, and similar equipment with exposed energized parts and prevent unauthorized access.

d) Approved perimeter marking shall be used to isolate restricted areas from designated work areas and entryways and shall be erected before work begins and maintained for entire duration of work. Approved perimeter marking shall be installed with either red barrier tape printed with the words " DANGER-HIGH VOLTAGE" or a barrier of yellow or orange synthetic rope, approximately 1 to 1.5 meter above the floor or work surface.

e) All gantry track shall be suitably earth at multiple locations at regular intervals.

f) All temporary metal structures like barricade boards, temporary metal containers/shed etc. shall be adequately earthed through suitable means.

g) All earth pits shall be properly numbered along with display of resistance value and inspection records of the same shall be maintained.

4.10.13. **Work on or near live conductors**

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless-

a) It is unreasonable in all the circumstances for it to be dead; and

b) It is reasonable in all the circumstances for him to be at work on or near it while it is live; and

c) Suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

4.10.14. Whenever pilling work is undertaken manually through tripod in the influence zone of live OHE, method statement shall be prepared, submitted, and got approved before start of work.

4.10.15. **Inspection and Maintenance**

a) All electrical equipment should be permanently numbered and a record kept of the date of issue, date od last inspection and recommended inspection period.

b) Fixed installations shall be inspected at least at three monthly intervals; routine maintenance being carried out in accordance with equipment manufactures recommendations.

c) All Electrical panels/DG panels/Distribution boxes etc. shall be provided with rubbers mats.

4.10.16. **25KV AC 50Hz single phase Traction:**

a) Induction effect of 25 KV AC 50 Hz single phase Traction

i) The attention of all staff is drawn to the fact that under 25kv ac 50 Hz single phase traction, there is heavy induction on all metallic structures and conductors in the vicinity of the track. The induction is two- fold

- Electro- static, which results from the high potential of 25 kv on the OHE system.
- Electro- magnetic, which is proportional to the currents passing from the sub-station to the OHE to the locomotives/EMUs and back partly through the earth.

ii) The voltage induced is quite appreciable on overhead conductors running parallel to the tracks depending on the length of parallelism. This explains why most of the overhead telecommunication's lines are replaced by underground cables. Special protective measures are required to reduce the adverse effects of induction.

iii) In a railway yard, voltage of the order of 200 volts may be induced on yard lighting mains situated 8 m away from the center of a double-line track, of it runs parallel to the 25 KV lines for a distance of about 270 m; it could be several thousand volts when parallelism is much longer. In such a case, a dangerous voltage due to induction will exist even after power supply to the line has been switched off. No one shall therefore attempt to work on any overhead line running alongside the electrified tracks without taking special precautions of earthing on both sides of the work. Before a section is electrified, the necessary modifications to distribution lines in all stations and yards should be carried out, so as to limit the induced voltage within permissible values, but this by no means limits the need for earthing the lines on both the sides of the working party. Earthing should be done individually by each working party as close to the work spot as possible. The distance between the two earths shall not exceed 1 km.

iv) Such inductive effects occur on large metallic structures such as fencings, structural steelwork of platforms running parallel to the track. They will therefore, have to be earthed suitably to afford safety.

v) Inductive effects also show themselves on any metallic conductor, such as metallic clothes- lines, power lines and lines belonging to private parties running parallel and close to the electrified tracks. Wide publicity should be given to the effects of induction so that special precautions are taken by the private parties.

b) General Precautions

The precautions laid down below must be followed under all circumstances in sections equipped for 25 kv as single phase, 50 Hz traction.

i) No work shall be done above or within a distance of 2 m from the live OHE without a " permit-to-work."

ii) No part of a tree shall be nearer than 4 m from the nearest live conductor. Any tree or branches likely to fall on live conductor should be cut or trimmed periodically to maintain this clearance. Cutting or trimming should be done by the OHE staff themselves or through an agency manage and supervised by them.

iii) Work for trimming of trees should also be done in the presence of authorized OHE staff or supervisor to maintain the safe clearance of 4 m any dispute regarding cutting of trees may be done on contract basis or departmentally of the terms & conditions of concerning deptt.

iv) No fallen wire or wires shall be touched unless power is switched off and the wire or wires suitably earthed. In case the wires drop at a level crossing, the Gate-keeper shall immediately make arrangements to stop all road traffic and keep the public away.

v) As far as possible closed wagons shall be used for material trains. In case open or hopper wagons are used, loading and unloading or such wagons in electrified tracks shall be done under the supervision of an Engineering official, who shall personally ensure that no tool or any part of the body of the worker comes within the 'danger zone' i.e., within 2 m of the OHE.

vi) Permanent way staff should keep clear of the tracks and avoid contact with the rails either when approaching or reaching the work-spot when an electrically hauled train is within 250m.

vii) When unloading rails alongside the tracks, it should be ensured that rails do not touch each other to form a continuous metallic mass of length greater than 300m.

c) Safety precautions on Electrified Sections (Chapter-IV), Electrical Accidents (Chapter-V), Fire precautions (Chapter-VI) of Indian Railways AC Traction Manual Volume – 1, as applicable may be followed.

d) The Training and Competency Certificates (Chapter XII) of Volume-II, Part-I of Indian Railways AC Traction Manual may be followed.

e) Power Blocks and permit to work are required to be taken in case of construction work going on in the vicinity of electrified line as per applicable Para of Chapter – VI of Volume-II, Part-I of Indian Railways AC Traction.

4.10.17. **Hand Tools and Power Tools**

a) The contractor is wholly responsible for the safe condition of tools and equipment used by his employees and that of his sub-contractors.

b) Use of short/damaged hand tools shall be avoided, and the contractor shall ensure all his hand tools used at his work site are safe to work with or stored and shall also train his employees (including his sub-contractors) for proper use thereby.

c) All hand tools and power tools shall be duly inspected before use for safe operation.

d) All hand tools and power tools shall have sufficient grip and the design specification on par with national/international standards on anthropometrics.

4.10.18. **Hand tools:** Hand tools shall include saws, chisels, axes and hatches, hammers, hand planes, screw drivers, crow bars, nail pullers.

4.10.19. The contractor shall ensure that;

a) For crosscutting of hardwood, saws with larger teeth points (no. of points per inch) shall be preferred to avoid the saw jumping out of the job.

b) Mushroom headed chisels shall not be used in the worksite where the fragments of the head may cause injury.

c) Unless hatchet has a striking face, it shall be used as a hammer.

d) Only knives of retractable blades shall be used in the worksite.

e) No screwdrivers shall be used for scraping, chiseling of punching holes.

f) A pilot hole shall always be driven before driving a screw.

g) Wherever necessary, usage of proper PPEs shall be used by his employees.

4.10.20. **Power tools**

4.10.21. Power tools include drills, planes, routers, saws, jackhammers, rinders, sprayers, chipping hammers, air nozzels and drills.

4.10.22. The contractor shall ensure that

a) Electric tools are properly grounded or/and double insulated.

b) Ground fault Circuit interrupters (GFCIs)/ Residual Circuit Breakers (RCCBs) shall be used with all portable electric tool operated especially outdoors or in wet condition.

c) When operating in confined spaces or for prolonged periods, hearing protection shall be required.

d) Tool is held firmly and the material is properly secured before turning on the tool.

e) All drills shall have suitable attachments respective of the operations and powerful for ease of operation.

f) When any work/operation need to be performed repeatedly or continuously, tools specifically designed for that work shall be used. The same is applicable to detachable tool bit also.

g) Size of the drill shall be determined by the maximum opening of the chuck in case of drill bit.

h) Attachments such as speed reducing screwdrivers and buffers shall be provided to prevent fatigue and undue muscle strain to his workers.

i) Stock should be clamped or otherwise secured firmly to prevent it from moving.

j) Workers shall never stand on the top of the ladder to drill holes in walls/ceilings, which can be hazardous, instead standing on the fourth or fifth rung shall be recommended.

k) Electric plane shall not be operated with loose clothing or long scarf or open jacket.

l) Safety guards used on right angle head or vertical portable grinders must cover a minimum of 180^0 of the wheel and the spindle/wheel specifications shall be checked.

m) All power tools/hand tools shall have guards at their nip points.

n) Low profile safety chain shall be used in case of wood working machines and the saw shall run at high rpm when cutting and also correct chain tension shall be ensured to avoid 'kickback'.

o) Leather aprons and gloves shall be used as an additional personal protection auxiliary to withstand kickback.

p) Push sticks shall be provided and properly used to hold the job down on the table while the heels moves the stock forward and thus preventing kickbacks.

q) Air pressure is set at a suitable level for air actuated tool or equipment being used. Before changing or adjusting pneumatic tools, air pressure shall be turned off.

r) Only trained employees shall use explosive actuated tools and the tool shall also be unloaded when not in use.

s) Usage of such explosive actuated tools shall be avoided in case of places where explosive/ flammable vapours or gases may be present.

t) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use.

u) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project.

v) No worker shall point any power operated/hand tool to any other person especially during loading/unloading.

4.11. Illumination

4.11.1. The Contractor shall provide sufficient site lighting, of the right type and at the right place for it to be properly effective as per the relevant national standards & guidelines.

4.12. Welding and Cutting

4.12.1. Gas cylinders in use shall be kept upright on a custom-built stand or trolley fitted with a bracket to accommodate the hoses and equipment or otherwise secured. The metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.

4.12.2. Test Certificate for cylinders and Vendor license shall be obtained. Gas Cylinder Act & Rules shall always be followed at workplace.

4.12.3. All gas cylinders shall be fixed with pressure regulator and dial gauges. clamp or clip shall be used to connect hoses firmly in both sides of cylinders and torches.

4.12.4. Non-return valve and flashback arrester shall be fixed at both end of cylinder and torch.

4.12.5. Domestic LPG cylinders shall not be used for gas welding and cutting purpose.

4.12.6. Dry Chemical Pressure (DCP) or CO2 type Fire Extinguisher not less than 5 kg shall be fixed at or near to welding process zone in an easily accessible location. Fire extinguisher should confirm to IS 2190:1992.

4.12.7. Oxygen cylinders and flammable gas cylinders shall be stored separately, at least 6.6 m (20 feet) apart or separated by a fireproof, 1.5 m (5 feet) high partition. Flammable substances shall not be stored within 15m of cylinder storage areas.

4.12.8. Welding grounds and returns should be securely attached to the work by cable lugs, by clamps in the case of stranded conductors, or by bolts for strip conductors. The ground cable will not be attached to equipment or existing installations or apparatus.

4.12.9. All electrical installations shall meet the IS: 5571: 1997 and NFPA 70 for gas cylinder storage area and other hazardous areas.

4.12.10. Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g. on the other side of bulkheads).

4.12.11. Transformer used for electrical arc welding shall be fixed with ammeter and voltmeter and fixed with separate main power switch.

4.12.12. Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

4.12.13. The current for Electric arc welding shall not exceed 300 A on a hand welding operation.

4.13. Excavation General

4.13.1. References:

a) The Haryana Building and other construction workers (Regulation of Employmentof conditions of Service) Rules, 2005;

b) IS: 3764 -1992 (Re-affirmed 1996): Code of Safety for Excavation Work;

c) IS: 4756 -1978 (Reaffirmed 1996): Safety Code for Tunnelling Work;

d) BS 6164: 2011 (Code of practice for health and safety in tunnelling in the construction industry);

e) BS EN 16191: 2014 (Tunnelling Machinery-Safety requirements);

f) IS 4081:2013 Blasting and related drilling operations-code of safety.

4.13.2. The Contractor shall ensure:

a) Where any construction & building worker engaged in excavation is exposed to hazard of falling or sliding material or article from any bank or side of such excavation which is more than 1.5 m above his footing, such worker shall be protected by adequate piling and bracing against such bank or side;

b) Undercutting during excavation shall be avoided. Whenever it is inescapable and banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank;

c) Excavated material is not stored at least 0.65 m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and the banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or fall upon a construction building worker working below such bank;

d) Metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards;

e) Trench and excavation is protected "against falling on a person by suitable measures if the depth of such trench or excavation exceeds 1.5m and such protection is an improved protection in accordance with the design and drawing ofa professional engineer, where such depth exceeds 4.0m;

4.13.3. Warning Signs and Notices:

The Contractor shall ensure that suitable warning signs or notices, required for the safety of workers carrying out the work of an excavation, shall be displayed or erected at conspicuous places in Hindi and in a language understood by most of such workers at such excavation work.

4.14. Tunnelling Works

4.14.1. The Contractor shall inform in writing to the Chief Inspector of Government of Haryana within 30 days, prior to the commencement of any tunnelling work.

4.14.2. The Contractor shall appoint a responsible person for safe operation for tunnelling work as per BOCWR.

4.14.3. In addition to general precaution such as display of warning sign/notices, deployment of trained staff, housekeeping, etc., the Contractor shall ensure that:

a) All portable electrical hand tools and inspection lamp used in underground and confined space at an excavation or tunnelling work is operated at a voltage not exceeding 24V;

b) Every compressed air system in a tunnel is provided with emergency power supply for maintained continued supply of compressed air ad per Rule 155 of BOCWR.

c) Only flame proof equipment of appropriate type as per IS: 5571:2000 and or another relevant national standard is used inside the tunnel;

d) Petrol or LPG of any other flammable substances are not used, stored inside the tunnel except with prior approval from the Engineer, and no oxy-acetylene gas is used in a compressed air environment in excavation or tunnelling;

e) Adequate number of water outlets provided for fire fighting purpose, an audible fire alarm and adequate number and types of fire extinguishers are provided and maintained;

f) Temperature in any working chamber in an excavation or tunnelling work where workers employed does not exceed 29°C as per Rule 165 of BOCWR;

g) All working areas in a free air tunnel are provided with ventilation system as approved by the Chief Inspector of Government of Haryana and the fresh air supplied in such tunnel is not less than 6 m3/min for each worker employed in tunnel and the free air flow movement inside such tunnel is not less than 9.0 m/min as per Rule 153 of BOCWR;

h) The oxygen level shall not be less than 19.5% in the working environment;

i) The excavated areas are made safe by use of suitably designed and installed steel sets, rock bolts or similar other means;

j) The responsible person referred to in BOCWR examines and inspects the workplaces in a tunnel before the commencement of work in such tunnel, and at regular intervals thereafter, to ensure safety of the Workers in such tunnel;

k) The portal areas of a tunnel with loose soil, or rock, likely to cause injury to a person are adequately protected with supports;

l) The Contractor shall ensure safe means of access to enter into tunnel.

m) The Contractor shall establish controlled Access/Egress system for the tunnel entry. Tally board system shall be adopted where any person entering the tunnel shall register his/her details before entering.

n) All life saving and fire fighting facilities shall be arranged in accordance with BS 6164 latest version.

o) The Contractor shall ensure continuous gas monitoring inside the tunnel before and after the blasting. Monitoring of the gas shall also be conducted with the help of hand held gas monitors. Such instrument shall be calibrated on regular basis.

p) The Contractor shall install emergency illumination (with battery backup) at an interval of not less than 15 m.

4.14.4. Means of Communication

The Contractor shall ensure that: reliable and effective means of communication such as telephone or walkie-talkie is provided and are maintained in working order for arranging better and effective communication at an excavation as per Rule 136 of BOCWR.

4.14.5. Permissible Limit of Exposure of Chemicals

The Contractor shall ensure that the responsible person referred to in BOCWR conducts necessary test before the commencement of a tunnelling work for the day and at suitable intervals as fixed by Chief Inspector to ensure that the permissible limits of exposure are not exceeded, and a record of such test is maintained and is made available for inspection to Chief Inspector, on demand.

4.14.6. Rock Fall Prevention (NATM)

The Contractor shall:

a) Draw up a method statement that includes preventive measure to fall of rock, tunnel face watching, evacuation methods from the face, and the construction sequence etc. to ensure that workers are informed.

4.14.7. Evacuation and Training

The Contractor shall ensure that:

a) Implementation of the training for evacuation and fire fighting immediately before the distance reaches about 100m from the portal to the tunnel face; and

b) Implementation of evacuation training by a responsible person appointed in terms of dealing with technical matters.

4.15. Blasting and Drilling

4.15.1. The following standards whichever is more stringent shall be applicable:

a) Safety Code for Blasting and Drilling operation IS 4081:2013;

b) Safety Code for tunnelling Work IS 4756-1978;

c) Code of practice for construction of tunnels IS 5878;

d) The Haryana BOCWR ; 2005 and Other Relevant National Legislations & IS Codes; and

e) Code of Practice for the safe use of explosives in the construction industryBS 5607:1988.

4.15.2. The Contractor shall ensure that all blasting operations will only be permitted following consultations with the relevant authorities and subsequent issuing of the permission to blast permits. The Engineer must also give his consent in writing before any blasting operations take place.

4.15.3. The Contractor shall:

a) appoint the manager, the deputy manager and officer in charge of handling explosives to prevent handling accidents;

b) when doing blasting work, the Contractor shall appoint a work supervisor from among those who can take on the blasting work;

c) All blasting shall be conducted under the direct supervision of a Licensed Shot firer.

4.15.4. Handling of explosives- as per Rule 278 HBOCWR;

The Contractor shall ensure at a construction site of a building or other construction work that-

a) All explosives are handled, used or stored in accordance with the instructions and the material data sheet supplied by the manufacturer of such explosives;

b) The use of explosives is carried out in safe manner to avoid injury to any person and under the direct supervision of a responsible person;

c) Before using any explosive, necessary warning and danger signals are erected, at conspicuous places of such use to warn the building workers and the general public of the danger involved in such use.

d) Safety Precautions- as per Rule 279 of HBOCWR;

The Contactor shall ensure at a construction site of a building or other construction work that-

i) Notwithstanding the provisions of rule 278, the following precautions are observed at the places of transporting, handling, storage and use of such explosives, namely-

ii) Prohibition of smoking, naked lights and other sources of ignition in the vicinity where explosives are handled, stored and used;

iii) To keep safe distance and to use non-sparking tools while opening packages containing explosives;

iv) To stop the use of explosives and handling thereof while the weather conditions are not suitable for such use or handling.

v) In addition to the provisions of this chapter, all measures, and precautions

vi) required to be observed for use, handling, storing or transportation of explosives under the rule framed under the Explosives Act, 1884(4 of 1884), are observed.

4.15.5. Risk Assessment and Method Statements

The Contractor shall produce a detailed hazard and risk assessment and an in depth method statement for amongst others the following elements:

a) Type of explosives to be used;

b) Anticipated effects of vibration on nearby structures;

c) Blasting patterns;
d) Delivery of the explosives;
e) Transportation and storage of explosives on site;
f) Drilling and charging of holes;
g) Warning sirens;
h) Measurement of Vibration;
i) Use of blast screens;
j) Ventilation following blasting;
k) Atmosphere monitoring;
l) Procedure for miss-fires;

4.16. Material Transportation

4.16.1. The Contractor shall develop the System Procedure/Methods Statement for heavy/big material/machinery transportation such as Rolling Stock, Transformer, and Bridge Main Girder, etc.

4.16.2. The Contractor shall ensure that the person in charge should inspects the safety implementation like properly fixing of wire with vehicle slab bed, condition of vehicle breaks etc. before starting the job and record the accidents and records.

4.16.3. The Contractor shall ensure that every vehicle/moving machinery should have a signal man who has a whistle, a flag or a signal light (in the night) with striking clothes and stands at a safe visible place from a machine operator by means of the proper signal and way determined.

4.16.4. The induction related to moving and parking safely should be given to driver/operator like parking construction vehicles at a specified place with a parking brake and making sure to put a drag.

4.17. Foundation Works

4.17.1. The Contractor is required to evaluate the risk in each activity and suggest a control measures of piling works:

a) Covering of bore holes with adequate warning signs;
b) Cage to be lowered by using crane;
c) The auxiliary hook of the rig shall not be used to pull or lower the cage in bore hole;
d) The tremie pipe lowering and lifting after concreting shall be done by using crane;
e) Control measure to arrest polymer spillage from the site to avoid contaminating the surface drains;
f) An entry restraining fence shall be provided around the pier excavation completion;
g) No man suffering from any chronic disease, alcoholic excess, ear or heart troubles or having a sluggish blood circulation or who has excess of fat should be employed as a diver;

4.18. Batching Plant and Casting Yard

4.18.1. The Contractor is required to evaluate the risk in each activity and suggest Control Measures:

a) Adequate space between the casting bed, segment storage area and the adjoining road shall be maintained so that a steel railing could be installed to segregate the gantry crane movement area from the road;
b) All safety precautions stated in Sub-Clause4.8[Construction Machinery], Automatic Safe Load Indicator (ASLI) for crane and gantry shall be complied during erection of gantry crane and other equipment;

c) The aggregate/sand storage area shall be kept under the full coverage of effective water sprinkler to avoid dust generation;

d) The entire batching plant/aggregate storage Area shall be adequately walled of sufficient height, above which the Contractor is required to erect green dust protective net. This is a mandatory requirement to avoid dust in surrounding environment;

e) The batching plant and casting yard required to obtain ''Consent to Establish'' and

f) ''Consent to Operate'' certificate from State Pollution Control Board;

g) The batching plant/casting yard shall be barricaded and made as a compulsory Personal Protective Equipment (PPE) zone;

h) Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation;

i) Drainage shall be effectively provided, and waste water shall be disposed after proper treatment; and

j) Manual handling of cement shall be avoided. Whenever it is necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.

4.19. Form Works

Ensure no attaching equipment to the formwork assembly unless specifically designed for this purpose; and not using a stripping process which may cause damage to the permanent structure.

4.20. Concrete Works

a) Concrete pumping equipment, trucks etc. are not to be washed down on site and any waste-water, concrete slurry or other contaminants are to be contained; and

b) These contaminants are not to be discharged into or onto roadways, footpaths, gutters, drainage systems, watercourses or any other surface area that will result in damage to the environment or contravenes environmental legislation.

4.21. Pier Casting Works

a) Using crane to hold the pier reinforcement during the time gap between de-staging and placement of shutter; and

b) Location and pier height specific securing arrangement and specific Method Statement for pier more than 9.0 m shall be submitted and approved by the Engineer.

4.22. Bridge Erection Works

4.22.1. References:

a) The BOCW Acts and Rules;

b) The Haryana BOCW Rules 2005;

c) Indian Railways Bridge Manual; and

d) Safety Assessment with regard to Steel Bridge Erection Works 1985, Ministry of Health, Labour and Welfare;

4.22.2. General

As bridge erection works are one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing temporary yard, casting segments, transporting segments, fabrication and operation of erection machinery, if any, launching of segments/lifting of segments, pre-stressing, cutting and welding, auto (or manual) launching and dismantling of erection machineries. For pre-stressed concrete bridges, the Contractor shall further ensure that:

a) a responsible person should be appointed for post-tensioning works testing and inspection of tendon tensioning devices and using material;

b) installation of protective board behind a tensioning jack and keep out behind a jack during tensioning;

c) use of protective glasses, laver gloves, and masks during grouting for safety of the Workers; and

d) fall prevention installation of overall boarding at the bottom of a bridge and installation of funnel type boarding at the side of a bridge during construction in case of RFO (Railway Flyover) or ROB (Road over Bridge) for preventing the flying and fall of materials and tools by safety net, should be ensured.

4.22.3. The Contractors Obligation

The Contractor shall prepare a comprehensive method statement for the bridge erection works, adhering to the ESHS conditions laid down herein. Particular reference shall be made to the provisions on working at height. As the entire process of launching/lifting has to be undertaken at the site especially during night time, the safety of workers is of paramount important. Daily inspection of scaffold structure and mechanical equipment for the traveller crane should be done.

4.22.4. Basic Consideration under site Condition:

Erection works over or adjacent roads or highways:

a) The work area should be demarcated properly, and route map and traffic management plan should be developed and implemented with proper signages and

b) caution;

c) The Contractor shall ensure the implementation of proper stop traffic and detour plan;

d) The Contractor shall arrange the proper guide and signs to be followed while working on highway or adjacent roads, railways; and

e) The Contractor should plan and establish all the required measures for the protection of overhead wires and buried utilities.

i) The regular inspection is done for all the installed protection equipment;

ii) The movement restriction site plan to be developed with defined operation path for safe working at site;

iii) watchmen should be appointed who are given training related to all type of traffic management and all signals used for smooth traffic flow and site transportation and works;

iv) The railway schedule is taken in consideration while planning the site works and ensures the safe management system with the details given regarding the kind of works suspended while a train is passing and clarifying the way of opening or closing railway in case of track closure works. For steel truss bridges;

v) The Contractor must install the protective net just after erecting truss upper chord material;

vi) The Contractor must install safety operation path to an end of erected member and a cross point of lateral bracing;

The Contractor may use any of the erection methods. However, following general points will be kept in view and ensured as applicable-

A. The Contractor should develop and confirm the Engineer his Method Statement with details of position of bearing, jacking operation, roller passing etc.;

B. Detailed inspection report related to the movement and condition of superstructure from the place of launching equipment and rollers should be given to the Engineer;

C. The Contractor shall give confirmation of binding situation such as a bolting erection member;

D. The Contractor shall give confirmation of displacement per every erection phase;

E. The Contractor shall give confirmation of fixing situation for bearings;

F. The Contractor must take measures to avoid a fall and lateral buckling of member; and

G. The Contractor shall take measures of fall prevention for main superstructure.

4.23. Building and Roof Erection Works

4.23.1. The Contractor shall plan erection sequence and work procedures properly under competent and experienced personnel to ensure the safety of workers and prevent structure failure during erection:

a) Contractor shall develop and confirm with the Engineer his method statement with details;

b) The stability of structural members is to be ensured by means of ties, braces, anchor/fixing bolts, or other suitable means before releasing lifting gear, slings, chains etc;

c) Tag lines must be attached to the ends of components/loads to maintain control during crane lifting operations;

d) Structure stability is to be ensured always. Unattended and incomplete buildings/structures are NOT to be left in an unsafe and hazardous condition, to pose a risk to the safety and health of site personnel or the public;

e) The Workers placing and securing roof battens are to be protected and are to work from an enclosed environment (e.g. scaffolding, deck guardrail or equivalent) and work up from the bottom of the truss/rafter towards and finish at the ridge /peak of the roof framing; and

f) When the spacing of trusses and roof battens exceed 600mm the appropriate procedures are to be considered and applied after conducting a risk assessment to provide the optimum fall protection.

4.24. Overhead Contact Wire Works

4.24.1. During starting of works using rack vehicle/moving scaffold/ladder/insulation tower/step ladder, etc., the Contractor's operation in charge shall confirm as follows:

a) The work sequence shall be determined while using Ariel Track vehicle. Communication system between drivers and conductors shall be developed and adopted;

b) A deck which must be used by workers, shall have enough capacity of carry necessary loads for work at a high place with a pre-operation inspection;

c) The workers shall be given the safety protection equipment which has enough capacity to hold necessary loads to prevent any accidental fall with a pre-operation inspection;

d) State of electrical equipment installation and a route of going up and down from ground;

e) The Worker is given required training for electrical works at height and the Worker must use a safety rope, an auxiliary rope, a fall prevention equipment such as a rolip which is a fall arrest device for a fixed rope when they work at high place;

f) The Worker shall fix the grip of an auxiliary ropes at the upper position of their safety ropes and uses special wires or a lift when delivering materials and tools from ground to high place;

g) The Contractor shall ensure that no one lean out of the rail of the track vehicles, or take a foot on the rail; and Shall take all the precautions for self-propellant or roll prevention when bringing the track vehicle to a stop;

_

h) The installation of medium rail at the place where handrail is more than 85cm high;

i) The training is given to all, for putting on a foot brake when bringing the rolling tower to a stop or working on the deck of the rolling tower suspended;

j) Putting on a foot brake and fixing the insulation tower by an assistant when bringing the insulation tower to a stop or working on its suspension;

4.24.2. While going up and down along an Electric Pole, Power Pylon or a High Steel Structure or working above it, the Contractor shall ensure the safety precautions mentioned below:

a) Use of a safety rope, an auxiliary rope and a fall prevention equipment with using an exclusive scaffold when going up and down along the electric pole;

b) Use of an escort rail, or both a Full Body Harness and an auxiliary rope when going up and down along the power pylon or the high steel structure;

c) While working on a Beam, the Contractor shall ensure the safety precautions mentioned below:

i. Use of a horizontal rope on working consecutively on the beam or painting the beam surface without an auxiliary rope; and

ii. Use of a safety rope and an auxiliary rope when moving on the beam under unavoidable circumstances.

4.25. Locomotives and Wagons

4.25.1. Speed limit is determined, and traffic signs of speed limits, lights and related hazards signage and cautions shall be installed at workplace overrun prevention equipment is installed on vehicles.

4.25.2. Person in charge shall be nominated as maintenance officer to inspect and repair temporary rails or track surface situation regularly.

4.25.3. Ensure the installation of an alarm device such as a horn and a buzzer, a head light, and a flood light for the driver's seat. Every driver of locomotive shall have the valid driving license.

4.25.4. Training and education shall be given to the driver and the signal man regarding how to send standard signal and operate vehicle diagram and turning off and putting on the brakes while the driver leaves his seat. And making sure to set wheel stoppers when stopping or parking at the slope track.

4.25.5. Each locomotive shall carry an extinguisher for fires

4.26. Rolling Stock Works

4.26.1. The Contractor shall ensure that:

a) All the compliances related to logistic of the rolling stocks according to the relevant local laws and regulations;

b) To comply with all the traffic rules and regulation and obtain all the permissions from the concern's local authority well in advance;

c) The Contractor shall develop Risk assessment of each individual activity with the Safe operating procedures;

d) The Rolling stock shall be prohibited to move while the Rolling stock is not planned to move and signage to this effect put on the rolling stock;

e) The Contractor shall indicate the energizing or de-energizing conditions of the Rolling stock by means of any way;

f) To inform/confirm a caution to all Workers in advance prior to energize or de-energize the Rolling stock or the OHE;

g) Prior to energize or de-energize the OHE, the Rolling stock shall be de-energized, and the pantographs shall be locked at housed position; and

h) The driver of vehicle such as shunter shall have enough knowledge and experience of driving skill and shall be sufficiently trained.

4.26.2. Testing and Commissioning and Trial Run Requirements

The Contractor shall ensure that:

a) The electrical isolation at the time of commissioning of the rolling stock;

b) Proper earthing system is provided at site;

c) The permit system duly approved by the Engineer while working with the various interface contractors;

d) To follow all the system developed by the Engineer to ensure the safety in interfacing various contractors; and

e) Ensure to discharge electrical energy from high voltage circuit prior to work on the roof.

4.27. Confined Space Entry

4.27.1. The Contractor must ensure all confined spaces are identified and managed using documented site confined space management methods.

4.27.2. When internal combustion engines are to be used into confined space or excavation or any other workplace where natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of workers shall be avoided unless suitable measures are taken and provided by the Contractor.

4.27.3. No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes/vapours or other impurities which is likely to be injurious or offensive, explosive or poisonous or noxious or gaseous material or other harmful articles unless steps are carried out by the Contractor and certified by the responsible person to be safe.

4.28. Fire Protection

4.28.1. The contractor shall ensure that the construction site is provided with—

a) Fire extinguishing equipment sufficient to extinguish any probable fire at such construction site;

b) An adequate water supply at ample pressure as per national standards;

c) Number of trained persons required to operate the fire extinguishing equipment provided; and

d) Is properly maintained and inspected at regular intervals of not less than once in a year by the responsible person and a record of such inspections is maintained.

4.28.2. The extinguishers shall be chosen as per type of fire load and surrounding location.

4.28.3. All construction machinery including crane shall carry a portable fire extinguisher in operator's cabin.

4.28.4. Emergency plan and Fire Evacuation plan in ESHS Management Plan shall be prepared and issued by the Contractor. Mock drills should be held on a monthly basis to ensure the effectiveness of the arrangements and as a part of the programme, the telephone number of the local fire brigade should be prominently displayed near each telephone on site.

4.28.5. Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

4.28.6. All drivers of vehicles, foreman, supervisors and managers shall be trained on operating the fire extinguishers and firefighting equipment.

4.29. Corrosive Substance

As per Rule 100 of HBOCWR, The contractor shall ensure that corrosive substances, including alkalis and acids, shall be stored and used by a person dealing with such substances at a building or other construction work in such a manner that it does not endanger the building worker and suitable protective equipment shall be provided by the contractor to a building worker during handling or use of such substances at a building or other construction work and in case of spillage of such substances on the building worker, immediate remedial measures shall be taken by the contractor.

4.30. Demolition

4.30.1. All demolition works be carried out in a controlled manner under the management of experienced and competent supervision.

4.30.2. The concerned department of the Government or local authority is informed, and permission obtained wherever required. Media shall also be informed regarding this concern.

4.30.3. All glass or similar materials or articles in exterior openings are removed before commencing any demolition work and all water, steam, electric; gas and other similar supply lines are disconnected.

4.30.4. No demolition work be performed if the adjacent structure seems to be unsafe unless and until remedial measures life sheet piling, shoring, bracing or similar means be ensured for safety and stability for adjacent structure from collapsing.

4.30.5. Debris/bricks and other materials or articles shall be removed by means of chute, bucket or other safe method.

4.30.6. No person other than the Workers or other persons essential to the operation of demolition work shall be permitted to enter a zone of demolition and the area be provided with substantial barricades.

4.31. Permit to Work

4.31.1. The Contractor shall develop work permit system, which is formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken.

4.31.2. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

4.31.3. A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work.

4.31.4. Examples of high-risk activities include but are not limited to:

a) Entry into confined spaces;
b) Hot work;
c) To dig where underground services may be located;
d) Work with heavy moving machinery;
e) Work with radioactive isotopes;
f) Heavy lifting operations and lifting operations closer to live electric power line;
g) Work with using track motor vehicles etc.; and
h) Work under electric facility and overhead electric (OHE) line energized.

4.31.5. The Contractor shall prepare operation manuals above mention and implement training course at any time based on such manuals to the Workers given completion of certificates before the commencement of works.

4.31.6. The permit-to-work system should be fully documented, laying down:

a) How the system works;

b) The jobs it is to be used for;

c) The responsibilities and training of those involved; and

d) How to check its operation.

4.31.7. A work permit authorization form shall be completed with the maximum duration period not exceeding 12 hours or end of shift, which is earlier.

4.31.8. A copy of each permit to work shall be displayed at work place. during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

4.32. Traffic Management and Site Barricading

4.32.1. The basic objective of the following guiding principles is to lay down procedures to be adopted by the Contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen in the all work areas.

4.32.2. The guiding principles to be adopted for safety in construction zone are to:

a) Warn the road user clearly and sufficiently in advance;

b) Provide safe and clearly marked lanes for guiding road users;

c) Provide adequate traffic marshals to regulate the movement of traffic;

d) Provide safe and clearly marked buffer and work zones; and

e) Provide adequate measures that control driver behaviour through construction zones.

4.32.3. In all cases, the Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, Specific Traffic Management Plans shall be drawn up and implemented by the Contractor in consultation with the approval of Local Police Authorities and/or the concerned politburo/Civil Authorities and followed to the IRC:SP;55- 2014 (Guidelines on Traffic Management in work zones) & IRC: 67 (Code of Practice for Road Signs).

4.33. Working near Railway

4.33.1. The details of Safe work procedure for work near Railway Track is given in **Attachment -5** of this document.

4.34. Other Works to be Scrutinized

4.34.1. Other works including, but not be limited to, the works in the site (the ROW), the works in the Borrow Pit, the works in the Quarry and Works on road shall be included to be scrutinised with respect to the accident prevention.

4.34.2. If blasting is anticipated in excavation in rock, preventive measures against accidents and protective measures against environmental/social impacts shall be of paramount importance.

4.34.3. The Contractor shall include all those items as well as work elements to formulate the preventive and protective measures considering envisaged conditions, situations, and activities of the works which may induce accidents or hazard to environment and/or society.

4.35. Personal Protective Equipment

4.35.1. The Contractor shall provide required PPEs to workmen to protect against safety and/or health hazards. Primarily PPEs are required for the following protection:

a) Head protection (Safety helmet with a chin strap);

b) Foot protection (Safety footwear, Gumboot, etc.);

c) Body protection (High visibility clothing (Waistcoat/Jacket), Apron, etc.);

_

d) Personal fall protection (Full body harness, Rope-grip fall arrester, etc.);

e) Eye protection (Goggles, Welders Glasses, etc.);

f) Hand protection (Gloves, Finger coat, etc.);

g) Respiratory protection. (Nose mask, Self-contained breathing apparatus, etc.); and

h) Hearing protection (Ear plugs, Ear muffs, etc.).

4.35.2. The PPEs and safety appliances provided by the Contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). If materials conforming to BIS standards are not available, the Contractor as approved by the Engineer shall procure PPE and safety appliances.

4.35.3. The Contractor shall provide the PPEs which the Contractor deems necessary including; but not be limited to, safety helmets, safety shoes to all the Contractor's Employees including workmen (including those of its sub-contractors). When and Where the Contractor thinks that he needs to provide the Contractor's Employees including workmen' (including those of its sub-contractors) with high visibility clothing as per the following requirement.

i) Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994;

ii) Background in fluorescent orange-red in colour;

iii) Jackets with full-length sleeves with two bands of retro reflective material, which shall be placed at the same height on the garment as those of the torso. The upper band shall encircle the upper part of the sleeves between the elbow and the shoulder; the bottom of the lower band shall not be less than 5cm from the bottom of the sleeve;

iv) Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2;

v) Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2;

vi) Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back;

vii) The bottom strip shall be at a distance of 5cm from the bottom of the vest; and

viii) viii) Strips shall be retro reflective and fluorescent.

Safety Helmet Colour Code (Every Helmet should have the LOGO*affixed/painted)	**Person to use**
Hard hat with company Logo (Employees)	Hard hat with reflective tape (Marshals)
White	Employer/Engineer
Grey	All designers, Architect, Consultants, etc.
Violet	Main Contractors (Engineers/Supervisors)
Blue	All subcontractors (Engineers/Supervisors)
Red	Electricians (Both Contractor andSubcontractor)
Green	Safety professionals (Both Contractor and Subcontractor)
Orange	Security guards/Traffic marshals

Yellow	All workmen
White (with "VISITOR" sticker)	Visitors
Safety Shoes (Anyone at the Site incl. Marshals)	
All employees of the contractor including workmen	Traffic marshals

Note: LOGO·

a) Logo shall have its outer dimension 2"X2" and shall be conspicuous
ii) Logo shall be either painted or affixed
iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

4.35.4. In addition to the above any other PPEs required for any specific jobs like, welding and cutting, working at height, tunnelling etc. shall also be provided to all workmen and also ensure that all workmen use the PPEs properly while on the job.

4.35.5. The Contactor shall not pay any cash amount in lieu of PPEs to the workers/sub- contractors and expect them to buy and use during work.

4.35.6. The Contactor shall at all-time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the Engineer during the inspections. Failing to do so shall invite penalty as per Clause 7. [Financial Deduction/Withholding].

4.35.7. It is always the duty of the Contactor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

4.35.8. The Contractor shall ensure that safety equipment and protective clothing is available and used on the site at all material times and those measures for the effective enforcement of proper utilisation and necessary replacement of such equipment and clothing shall be incorporated into the site ESHS Plan.

4.36. Visitor at site

4.36.1. No visitor can enter the site without the permission. All authorised visitors should report at the site office. The Contractor shall provide visitor's helmet (White helmet with visitor sticker) and other PPEs like Safety Shoe, reflective jacket, respiratory protection etc. as per requirement of the site. Entry of visitors in underground shall be suitably controlled.

4.36.2. The Contractor shall be fully responsible for safety and health of all visitors within the site.

4.37. Site Security

4.37.1. The Contractor shall be wholly responsible for security on the site and any other areas being used by him or the Subcontractor's for the purposes of the Contract. The Contractor shall implement and cause the Subcontractor's to implement proper security management procedures in accordance with the approved ESHS Management Plan.

4.37.2. The Contractor shall assign on the site a security officer (adequately trained person,) and his alternate(s), who shall be primarily responsible for the Contractor's security services and fully cooperate with the Engineer's security organization throughout the Time for Completion. Necessary approval of agency shall be obtained from the Engineer.

4.37.3. The security plan covered by the ESHS Management Plan shall contain the following:

a) Security policy statement and objectives;

b) The Contractor's security organization;

c) Role, responsibility and authority of each member of the security organization;

d) Procedure for enforcement of security regulations;
e) Daily, weekly and monthly security meeting procedures;
f) Sample forms for security reports;
g) Personnel security control procedures;
h) Goods security control procedures;
i) On-site security patrol procedures;
j) Liaison and coordination procedure with local fire/police and other authorities;
k) Liaison and coordination procedure with the Employer and relevant other authorities; and
l) Liaison, coordination and joint security inspection procedure with other Contractors.

4.37.4. Where necessary, the Contractor shall install, modify, maintain and remove the temporary security fences, gates, posts, security lightings and other facilities required for proper security control, in addition to those to be constructed as part of the Works. The Contractor shall operate these facilities to properly control ingress to and egress from the areas under his control throughout the Time for Completion. This control shall apply to every person including the Employer's Personnel.

5. OCCUPATIONAL HEALTH AND WELFARE

5.1. Physical Fitness of Workmen

5.1.1. The Contractor shall ensure that his employees/workers subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

5.1.2. The Contractor shall not permit any employee/workers to enter the work area under the influence of alcohol or any drugs.

5.1.3. The Contractor shall maintain the confidential records of medical examination or the physician authorized by the Engineer.

5.1.4. No worker is charged for the medical examination and the cost of such examination is borne by the Contactor employing such worker.

5.1.5. If the Contractor fails to get the medical examination conducted as mentioned above, the Engineer will have the right to get the same conducted through an agency with intimation to the Contractor and deduct the cost and overhead charges from his dues.

5.2. Medical Facilities

5.2.1. Occupational Health Centre (First Aid Station)

The Contractor shall ensure at a construction site an occupational health centre, mobile or static is provided and maintained in good order. Services and facilities as per the scale lay down in Schedule IV of HBOCWR. A construction medical officer appointed in an occupational health centre, possess the qualification as laid down in Schedule V Rule no 113 of HBOCWR:

5.2.2. The Contractor shall appoint appropriate full-time staff including one nurse, one dresser- cum-compounder, one sweeper-cum-ward boy with each construction medical officer.

5.2.3. The Contractor shall communicate the complete details including name, qualification and experience of the construction medical officer, to the inspector having jurisdiction under HBOCWR.

5.2.4. Ambulance Room, Ambulance Van and Stretchers:

The Contractor shall ensure at a construction site of a building or other construction work that an ambulance van and room are provided at such construction site or an arrangement is made with a nearby hospital for providing such ambulance van for

transportation of serious cases of accident or sickness of workers to hospital promptly and such ambulance van and room are maintained in good repair and is equipped with standard facilities specified in Schedule VI of Rule 114 & Schedule VII of Rule 115 of HBOCWR.

5.2.5. The Contractor shall provide enough stretchers at each site for use in an emergency.

5.2.6. First Aid Boxes and Emergency Care:

The Contractor shall ensure at construction site one First-aid box for 100 workers for providing first-aid to the workers. Every First-Aid box is distinctly marked "First-Aid" and is equipped with the articles specified in Schedule IX of Rule 119 of HBOCWR. Adequate no. of trained first aid persons shall be available at each work site in each shift.

5.2.7. HIV/AIDS Prevention and Control:

a) The Contractor shall adopt the Employer's "Workplace Policy on HIV/AIDS Prevention and Control for Workers Engaged by Contractors" and implement it. A copy of the policy is given in **Attachment-2 [Workplace Policy on HIV/AIDS Prevention & Control]**; and

b) The Contractor shall prepare and submit the Manual for HIV/AIDS Prevention and Control for his workers in terms of the aforesaid Employer's Policy within 28 days of the date of notification of the Contract.

c) The Contractor shall organize awareness program for labourers on the risks of AIDS and STDs in coordination with Haryana State AIDS Control society.

5.2.8. COVID -19 Prevention and Control

The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site. The Workplace Policy on COVID-19 Prevention and Control is given in **Attachment-3 [Workplace Policy on COVID-19 Response].** The Contractor shall undertake a COVID-19 risk assessment of project area and prepare and submit COVID-19 Response and Management Plan.

5.2.9. Prevention of Mosquito Breeding

Measures shall be taken to prevent mosquito breeding on the site. The measures to be taken shall include:

a) Empty cans, oil drums, packing and other receptacles, which may retain water, shall be deposited at a central collection point and shall be removed from the site regularly;

b) Stagnant water shall be treated at least once every week with oil to prevent mosquito breeding;

c) The Contractor's equipment and other items on the site, which may retain water, shall be stored, covered, or treated in such a manner that water could not be retained; and

d) Water storage tanks shall be provided.

5.2.10. Posters in local language, Hindi and English, which draw attention to the dangers of permitting mosquito breeding, shall be displayed prominently on the Site.

5.2.11. The Contactor at periodic interval shall arrange to prevent mosquito breeding by fumigation/spraying of insecticides, and the ideal larvicide etc.

5.2.12. Alcohol, Smoking and Drugs

The Contactor shall always ensure that no employee is working under the influence of alcohol/drugs which are punishable under BOCWR;

Smoking at public places by any employee is also prohibited as per Government Regulations. The Contractor shall comply with the legal provisions in this regard, such as; Prohibition of Smoking in Public Places Rules, 2008. He shall be solely responsible for any penalty or punitive action by the government authorities because violations of the provisions contained in these rules by him or his representatives or his employees or his Subcontractors. Requisite notice boards, posters, etc., shall be put by him, as per the Rules.

5.3. Occupational Noise

5.3.1. The Contractor shall comply with the codes, regulations and standards regarding noise pollution and control as notified and amended by Central Government and State Government from time to time on the site including but not necessarily limited to:

a) Chapter VII, Part -I, Schedule-I of Haryana BOCWR 2005;

b) Noise Pollution (Regulation and Control) Rules, 2000;

c) Environment (Protection) Act, 1986;

d) Environment (Protection) Amendment Rules, 2000; and

e) Central Motor Vehicles Rules, 1989;

f) Notification on Control of Noise from DG Sets, 2002.

5.4. Welfare Measures for Workers

5.4.1. Latrine and Urinal Accommodation:

a) Latrine and urinals shall be provided as per Chapter VI, Part – II of Rule 80 of Haryana BOCWR and shall also comply with the requirements of public health authorities; and

b) When women are employed, separate latrine and urinals accommodation shall be provided.

5.4.2. Moving sites:

a) In case of works like track laying, the zone of work is constantly moving. In such cases, mobile toilets with proper facility to drain the sludge shall be provided at reasonably accessible distance; and

b) In case the Contactor fails to provide required number of urinals and latrines or fails to maintain it as per the requirements of Public Health Laws, the Engineer shall have the right to provide/maintain through renowned external agencies at the cost of the Contactor.

5.4.3. **Canteen**

In every workplace wherein not less than 250 workers are employed, the Contractor shall provide an adequate canteen conforming to Chapter VI, Part – II of Rule 81 of Haryana BOCWR

5.4.4. **Drinking Water.**

As per Section 32 of BOCWA, the Contractor shall make in every site, effective arrangements to provide sufficient supply of wholesome drinking water. Quality of the drinking water shall conform to the requirements of national standards on Public Health Laws. While locating these drinking water facilities due care shall be taken so that these are easily accessible from the place of work for all workers at all location of the site. All such points shall be legible marked "Drinking Water" in a language understood by most of the workmen employed.

5.4.5. **Crèche**

In every workplace where in more than 50 female workers are ordinarily employed, there shall be provided and maintained a suitable room for use of children under age of 6 years, conforming to the provisions of Section 35 of BOCWA.

5.4.6. Labour Accommodation Camps

Labour camp management plan shall be prepared and approved by Engineer. Where workers are based some distance from their normal place of residence, the Contractor shall provide them with suitable and safe accommodation free of charge and shall take all necessary precautions to protect their health and welfare. The accommodation shall conform to the requirements of Section 34 of BOCWA and include but not be limited to the further measures specified hereunder.

5.4.7. All accommodation camps shall be provided always with a sufficient supply of clean drinking water (of potable quality according to national legal standards), in suitable and easily accessible locations:

5.4.8. The quality of drinking water shall be tested once a fortnight as prescribed in IS 10500:2012and immediate remedial action shall be taken if quality falls below the standard. Test results shall be provided to the Engineer at least monthly.

5.4.9. The Contractor shall provide all accommodation camps with clean and properly equipped and staffed kitchen and canteen facilities to supply meals for workers.

5.4.10. The Contractor shall provide sufficient toilet and bathroom facilities for the numbers of workers accommodated in each camp. Separate accommodation and toilet/bathroom facilities shall be provided for men and women and all facilities shall be kept in full working order always and cleaned and re-equipped daily.

5.4.11. The Contractor shall provide a laundry facility at the Labour Accommodation Camps.

6. ENVIRONMENT AND SOCIAL MANAGEMENT

6.1. General Conduct of the Works

6.1.1. The purpose and objective of these guidelines is to outline how the project will avoid, minimise or mitigate effects on the environment and surrounding area. These guidelines detail the implementation of measures in accordance with environmental and social commitments of HRIDC. These guidelines will be 'live' guidelines that will be reviewed and updated at regular intervals throughout the project life cycle. These guidelines will ensure that the development is compliant with current Environmental and Social legislations and will guide and assist the Contractor in exploring all reasonable and feasible means for reducing construction related Environmental and Social impacts.

6.1.2. The Contractor shall comply with the Environment and Social Management Plan (ESMP) given in the Environmental and Social Impact Assessment (ESIA) report available on HRIDC portal for information disclosure and will note and implement any requirements therein, in addition to those found in this specification.

6.1.3. The Contractor is required to build good public relations before the commencement of the Works particularly with the local level representatives such as the Gram Panchayat, by informing the expected impacts by the Works and their schedule and dispute resolution mechanism known as GRM set by the Employer.

6.2. Environmental Legislation

6.2.1. The Contractor shall always comply with all relevant National and State legislations regarding environmental protection, pollution prevention and control, waste management and other relevant environmental matters, including but not necessarily limited to, the following with their latest amendments:

a) The Environment (Protection) Act, 1986 and Rules 1986

b) The Indian Wildlife (Protection) Act, 1972;

c) The Forest (Conservation) Act, 1980 &Rules;

d) Punjab Land Preservation Act, 1900;

e) The Noise Pollution (Regulation and Control) Rules, 2000;

f) Notification on Control of Noise from Diesel Generator (DG) sets, 2002;

g) The Air (Prevention and Control of Pollution) Act, 1981and Rules 1981;

h) The Water (Prevention and Control of Pollution) Act, 1974 and Rules 1974;

i) Guidelines to control and regulate ground water extraction in India, 24th September 2020, Central Ground Water Authority;

j) The Solid Management Rules, 2016;

k) The Construction and Demolition Waste Management Rules, 2016;

l) The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016;

m) The Bio-medical Waste Management Rules, 2016;

n) Plastic Waste Management Rules, 2016;

o) E-Waste (Management) Rules 2016;

p) The Batteries (Management and Handling) Rules, 2001;

q) Manufacture, Storage, and Import of Hazardous Chemical (Amendment) Rules, 1989;

r) Ancient Monuments and Archaeological sites and Remains (Amendment and Validation) Act 2010;

s) Fly ash utilization notification, Sept 1999;

t) Applicable NGT Guidelines issued time to time; and

u) Provisions of Graded Response Action Plan notified by the MoEFCC.

6.2.2. The Contractor shall comply the Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016.

6.2.3. If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws, the more stringent requirements shall apply.

6.2.4. It is also the Contractor's responsibility to obtain all environment clearances, official approvals, consents, or other authorizations as may be necessary to comply with the relevant statutes, and to pay all related fees and other costs. The Contractor shall obtain all authorizations in a timely manner and submit to the Engineer as the evidence for the regulatory obligations before commencement of any related construction activity. The indicative clearances/permission/permit are presented in Table below and Contractor is required to take any other clearance as required for its construction activities.

Clearance/ Permission/Permit	Relevant Acts/Rules	Concerned Agency
Consent to Establish and Consent to Operate batching plants and casting yards	• The Water (Prevention and Control of Pollution) Act, 1974, and its amendments; • The Air (Prevention and Control of Pollution) Act 1981 and its amendments	Haryana Pollution Control Board
Authorization for generation, handling, storage, and transportation of hazardous waste	Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016	Haryana Pollution Control Board
Permission for extraction of ground water	Central Ground Water Authority guidelines to regulate and control ground water extraction in India, 24th September, 2020	Central Ground Water Authority
Pollution Under Control Certificate	Central Motor and Vehicle Act 1998 Vehicular Exhaust Norms, CPCB 2007	Department of Transport, Government of Haryana
Construction and Demolition Waste Management Plan	Construction & Demolition Waste Management Rules, 2016	Local Authority (Municipal Corporation)
Cutting of trees	*Deleted*	*Deleted*

6.3. Environmentally Friendly Construction Practices

6.3.1. Containment of Air Pollution

a) All construction equipment's should be cleaned of visible dirt/mud before exiting the construction sites and streets shall be promptly cleaned by manual sweeping, or by deploying electro – mechanical devices if such material has been dropped;

b) The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. This facility will be provided with efficient drainage, water re-circulation apparatus and silt traps to prevent any excessive buildup of water. Where wheel-washing facility is not possible, the Contractor shall ensure manual cleaning of wheels by wire brushes or similar suitable means;

c) The Contractor shall ensure that vehicles shall have properly fitted side and tailboards. No open load carrying vehicle shall be used for moving potentially dust-producing materials and dust potential material shall not be loaded to a level higher than the side and tail boards, and shall be fitted with cover lids or tarpaulin covers;

d) The Contractor shall place excavated materials in the dumping/disposal areas with suitable slopes designated in the drawings;

e) The Contractor shall place material in a manner that will minimize dust production. Material shall be stabilized each day by watering or other accepted dust suppression techniques;

f) Materials should not be dropped from more than 1.5 m to limit fugitive dust generation;

g) During dry weather especially on windy, water sprinkling must be used daily at every two hours intervals or at any time that it is required for dust control to prevent any dust from blowing and causing nuisance.

h) The Contractor shall provide storage facilities at each construction site in the form of closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Engineer.;

i) Stockpiles of sand and aggregate greater than 20m3 for use in concrete manufacture shall be enclosed on three sides, with walls extending above the stockpile and two (2) metres beyond the front of the stockpile;

j) Areas within the site such as construction depots and batching plants, where there is a regular movement of vehicles shall have an approved hard surface that is kept clear of loose surface material;

k) Unless the Engineer has given notice otherwise, the Contractor shall restrict all motorised vehicles on the site to a maximum speed of 15 kilometers per hour and confine haulage and delivery vehicles to the designated roadways inside the site;

l) The Contractor shall erect hoardings as specified in Engineer requirements securely around all construction work sites during the main construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic. The hoarding shall be safely secured to the ground to prevent from toppling with minimum gap between the base of hoarding and ground surface.

m) Water spray should be used to control dust during breaking of rock/concrete;

n) During tunnel construction the Contractor shall monitor dusts concentration, wind velocity, air capacity of ventilation system every month and will keep monitoring record including date, method, location, condition, results, and evaluation of results.

o) The contractor shall take all necessary actions to control air pollution as per guidelines issued by the commission for Air Quality Management in National Capital Region time to time.

p) The contractor shall take necessary actions as per the provisions of Graded Response Action Plan (GRAP) issued time to time.

6.3.2. **Containment of Water Pollution**

a) List of sources (surface/ground) to be provided for approval from Engineer;

b) Prior to use of source, written permission to be obtained from authority to use the water in construction activity, and submit a copy to Engineer;

c) During construction only permitted quantity (permission taken) from approved sources to be used in construction activity;

d) A Drainage system should be constructed during the commencement of the works, drain off all surface water at the site into suitable drains;

e) At construction depots and batching plants temporary drainage works should be maintained, removed, and reinstated as necessary and all other necessary precautions should be taken for avoidance of damage by flooding and silt;

f) The Contractor shall provide a hard surface with suitable drainage system for Transit Mixture washing at Casting Yard and/or Batching plant. The slurry water from Transit Mixture washing area shall go to sedimentation tank of suitable capacity to treat the slurry water. The contractor shall ensure the facility remains functional till the end of the contract;

g) The Contractor shall take measures to prevent discharge of oil on land and in water bodies. Oil separator/interceptors shall be provided at Batching Plant and Construction Depot location for vehicle maintenance to prevent the release of oils and grease into the drainage system. These shall be cleaned on a regular basis;

h) Open stockpiles of construction materials (e.g. aggregates, sand and fill material) should be covered with tarpaulin or similar fabric during rainy season or at any time of the year when rainstorms are likely. Washout of construction or excavated materials should be diverted to drainage system through appropriate sediment traps;

i) Rainwater pumped out from trenches or foundation excavation should be discharged into storm water drains after obtaining notice of no objection from the Agency controlling the system;

j) The Contractor shall prevent soil particles and debris from entering the wells or water discharge points by use of filters and sedimentation basins as required;

k) The Contractor shall always ensure that all existing stream courses and drains within, and adjacent to the site are kept safe and free from any debris and any excavated materials arising from the Works;

l) The Contractor shall discharge wastewater arising from site offices, canteens or toilet facilities constructed by him into sewers after obtaining prior notice of no objection of agency controlling the system;

m) The volume of oil spill should be calculated as well as storage volume to contain spill within the materials storage containment areas. The procedure shall include measures to contain and mitigate transportation of oil, grease or hazardous materials to the drainage system or any water body;

n) The Contractor shall ensure that earth, bentonite, chemicals and concrete agitator washings etc. are not deposited/drained in the watercourses but are suitably treated and effluents and residue disposed off in a manner approved by local Regulatory Authorities;

o) Construction works should be programmed to minimize soil excavation works in rainy season. If carried out during rains, temporarily exposed slope surfaces should be covered by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds.

p) Wastewater from Concrete Batching & Precast Concrete Casting and that generated from the washing down of mixer trucks and drum mixers and similar equipment should wherever practicable be recycled. The discharge of wastewater should be kept to a minimum;

q) The road between the vehicle washing bay and the public road should be paved to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains;

r) Surface run-off should be segregated from the concrete batching plant and casting yard area as much as possible and diverted to the storm water drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard must be treated to, within the discharge norms before disposal into storm water drains;

6.3.3. **Containment of Noise and Vibration**

a) Contractor shall minimize the use of impact devices, such as jackhammers, and pavement breakers and instead use concrete crushers or pavement saws;

b) Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations;

c) Use hydraulic tools instead of pneumatic impact tools. If pneumatic impact tools and equipment are used, they shall have intake and exhaust mufflers recommended by the manufacturers thereof, to meet relevant noise limitations;

d) Provide mufflers or shield panelling for other equipment, including internal combustion engines, recommended by manufacturers thereof;

e) Employ prefabricated structures instead of assembling on-site;

f) Use electric instead of diesel-powered equipment;

g) Provide enclosures for stationary equipment and barriers around noisy areas;

h) Locate stationary equipment in such a way, so as to minimize noise and vibration impact on community.

i) Keep noisier equipment and activities as far as possible away from noise sensitive locations and nearby buildings.

j) Plant and equipment known to emit noise strongly in one direction should where possible, be oriented in a direction away from noise sensitive receptor.

k) Reduce the number of plant and equipment operating in critical areas close to noise sensitive receptors.

l) Schedule truck loading, unloading, and hauling operations in such a way so as to minimize noise impact near noise sensitive locations and surrounding communities;

m) Plan noisier operations during times of highest ambient noise level, keep noise levels relatively uniform and avoid excessive and impulse noises;

n) Use only well-maintained, regular serviced plant/equipment, and not to be kept idling when not in use;

o) Maintain equipment such that parts of vehicles and loads are secure against vibrations and rattling;

p) Grading of surface irregularities on construction sites to prevent the generation of impact noise and ground vibrations by passing vehicles;

q) If back-up alarms are used on construction equipment, their noise emission level near noise sensitive receptors such as residences, schools, hospitals and similar areas where calmness is essential, should be regulated, especially at night time;

r) Select truck routes for muck disposal so that noise from heavy-duty trucks will have minimal impact on sensitive areas (e.g., residential);

s) Conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum;

t) Avoid operating truck on streets that pass by schools during school hours;

u) Efforts to be made to bring down the noise levels due to the DG set, outside the premises, within the ambient noise requirements by proper setting and control measures;

v) The Contractor shall ensure that all necessary permissions/ approvals/consent is obtained from relevant authorities before installation and operation of Generator set;

w) A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacture;

x) At all times noise levels of DG sets shall comply the standards set out by CPCB/SPCB;

y) During tunnel operation following measures to be taken:

   i) Blasting activities to be so schedule that local people are not disturbed and notify them prior to undertaking such activity;

   ii) Operations to be scheduled to coincide when people are busy with their daily tasks so that they would be least likely to be affected. Blasting operation shall not be carried out in night.

   iii) Charge mass per delay should be decreased by minimizing the number of blastholes firing on each delay.

   iv) Smaller blasthole patterns and longer delays shall be used between dependent charges.

   v) A preconstruction survey of nearby structure likely to be adversely affected by the construction activities to be performed and threshold or limiting values to be established that take into account each structure or use's ability to withstand the loads and displacements due to construction vibrations;

   vi) An extensive outreach to be conducted in advance in the surrounding villages that could be affected;

   vii) Vibration levels shall be monitored in the foundations of nearby buildings during all blasting activities. Blasting activities resulting in peak particle velocity (vibration) levels in excess of appropriate damage criteria as measured in the foundations of nearby structures would be immediately stopped until further precautionary measures are taken to reduce blasting-related vibration impacts.

   viii) Work shall not begin again until the steps proposed to stabilize and/or prevent further damage to the designated buildings are approved.

6.3.4. **Containment of Waste**

a) The Contractor is required to develop, institute and maintain a Waste Management Plan (WMP) during the construction of the project for his works, which may include:

   ix) Identification of disposal sites;

   x) Identification of quantities to be excavated and disposed off;

   xi) Identification of split between waste and inert material;

   xii) Identification of amounts intended to be stored temporarily on site and location of such storage;

   xiii) Identification of intended transport means and route;

   xiv) Obtaining permission, where required, for disposal;

b) Such mechanism is intended to ensure that the designated area for the segregation and temporary storage of reusable and recyclable materials are incorporated in the WMP. The WMP shall be prepared and submitted to Engineer for approval.

c) Construction activities are expected to generate a variety of waste such as:

   i) General refuse;

   ii) Construction and Demolition waste including waste from excavated material;

iii) Chemical waste;

iv) Hazardous waste; and

v) Biomedical waste.

All wastes shall be stored at a designated areas and not to be mixed with each other.

General Refuse

a) Each worksite would generate general refuse including paper and food waste which shall be stored in enclosed bins or units.

b) The Contractor shall not burn debris or vegetation or construction waste on the site;

c) The refuse shall be stored and transported in accordance with good practice and disposed at licensed landfills;

d) An authorised waste collector shall be employed by the Contractor to remove general refuse from the site, on a daily basis to minimise odour, pest and litter impacts.

Construction and Demolition (C&D) Waste

a) C&D Waste would mainly arise from the project construction activities and from the demolition of existing structures where necessitated. It will include: material and equipment wrapping packaging material, unusable/surplus concrete/grouting mixes, damaged/contaminated/surplus construction materials, wood from formwork and false work, concrete rubble, plastics, metal, glass, asphalt, wood and refuse obtained from demolition of houses.

b) The Contractor shall be responsible for collection, segregation, storage and disposal of C&D waste as directed or notified by the concerned local authority in consonance with the Construction & Demolition Waste Management Rules, 2016;

c) The Contractor shall ensure that there is no littering or deposition of C&D waste and disposal of C&D waste along the riverbed, natural drainage and wet land is strictly prohibited;

d) The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tons of C&D waste which has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier;

e) A proper arrangement for record keeping has to be maintained to ensure disposal of C&D waste to C&D waste recycling plant. Contractor shall submit the record of C&D waste disposal to recycling facility, in his Monthly Environment Report;

Hazardous Waste

f) Hazardous waste would mainly arise from the maintenance of equipment. These may include, but not be limited to: Used engine oils, hydraulic fluids, waste fuel, spent mineral oils/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents/solutions, some of which may be derived, from equipment cleaning activities which shall be disposed off in a manner in compliance with the procedure given in "Hazardous Waste (management, handling and trans-boundary movement) rules, 2016" only to authorized recyclers under intimation to the Employer's Representative ;

g) Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act;

h) The hazardous waste shall be stored on an impermeable surface with containment bunding to retain leaks, spills and ruptures;

i) All waste collection containers shall be of appropriate size with a closed lid. Each container will be clearly labelled with a colour code system in local language and English. Original labels of empty containers should be completely covered and the contents of the type of waste stored in the used containers clearly indicated.

j) Drip pans of suitable size and numbers shall be used to collect oil leakage and spills. The area shall be cleaned after completion of maintenances/repair and generated waste disposed off in approved manner.

Bio medical waste

k) Collection, segregation, storage and disposal of Bio Medical waste shall be in accordance with The Bio-medical Waste Management Rules, 2016;

l) Storage time of waste shall be as less as possible so that waste storage, transportation and disposal is done within 48 hours;

m) The contactor shall ensure Posters/ placards for bio-medical waste segregation shall be installed at the point of generation;

n) Disposal of biomedical waste shall be through a licensed waste collector, duly authorized by MoEFCC or Haryana Pollution Control Board as the case may be. License of the waste collector shall be shown to the Employer's Representative on demand. Staff handling the biomedical waste shall be provided with PPEs;

Storage and Segregation of Waste

a) Collection and storage points of appropriate size containers shall be established around all construction work sites, with a 'display board' showing quantity and nature of waste;

b) All waste shall be stored in different coloured bins as per table below:

Colour coding of Waste storage bins

Type of Waste	Colour
Wet/Organic/ Bio-Degradable Waste	Green Bins with lids
Dry/Recyclable waste (excluding Bio-medical waste/ hazardous waste)	Blue
Bio-Medical waste	Red with lids
E-Waste	Black
Hazardous Waste	Brown
COVID Waste	Yellow

6.3.5. Housekeeping

a) The Contractor along with his sub-Contractors shall maintain the site, labour camps, stores and offices reasonably clean, keep free from obstruction and properly store any construction equipment, tools, and materials.

b) Full height fence, barriers etc. will be installed at the site in order to preserve the surrounding area from excavated soil, rubbish etc. which may cause inconvenience to public.

c) The Contractor's through daily pre-work meeting (tool box talk), safety meeting etc. will impart the necessary education to labour on housekeeping. Other staff such as supervisors and engineers working at the site will also be educated on the necessity of good housekeeping;

d) The Contractor shall ensure the availability of dustbins in Labour Camps at required place and ensue regular cleaning of rooms, kitchens, toilet blocks and dustbins.

e) Proper access and stacking shall be ensured at the Stores. A list will display daily stock of materials.

f) Everyone shall be responsible to maintain housekeeping of their work station.

g) To keep the area free of litter and garbage, specific locations shall be designated for consuming food and snacks to prevent random disposal of waste.

h) Drip pans of suitable size shall be used to collect oil leakages and spills while plants/equipment/machinery maintenance.

i) The Contractor shall make available Material Supply Data sheet (MSDS) for material/chemicals/substances used, for which these are available to the Engineer when requested;

j) Such material/chemicals/substances used shall be treated, handled, stored, transported and disposed off, by the Contractor, in a manner specified in the MSDS.

6.3.6. Landscape, Greenery and Aesthetics

a) As far as is reasonably practicable, the Contractor shall maintain ecological balance by preventing deforestation and defacing of natural landscape. In respect of ecological balance, the Contractor shall observe the following instructions.

   i) Prevent any avoidable destruction, scarring or defacing of natural surroundings in the vicinity of work;

   ii) Any damage shall be repaired, replanted or otherwise corrected at Contractor's expense.

   iii) Directional shielding for light used for illumination shall be used to prevent from striking adjacent areas, where feasible;

b) Tree Felling

   i) All trees and shrubs, which are not specifically required to be cleared or removed for construction purposes, shall be preserved and protected from any damage by use of protective barriers or other methods approved by Engineer;.

   ii) The Contractor shall not fell, remove or dispose of any tree or forest produce in any land handed over to him for the construction of works and facilities related to project except with the previous permission obtained from the Forest Department;

   iii) Trees shall not be used for anchorage.

6.3.7. Energy Management

a) The Contractor shall use energy efficient pumps and motors. The efficiency shall be measured during installation and also periodically;

b) The Contractor should rigorously follow the maintenance regime of his DG sets;

c) The Contractor shall maximize the use of energy efficient luminaries such as LED's, metal halide lamps and ensure optimum illumination levels to save energy.

d) The Contractor shall make provision of Earth Leakage Circuit Breakers (ELCBS) to prevent loss of excessive earth currents which are unsafe;

e) The Contractor shall plan in advance and select locations to receive and store material such that these are at the least distance from place of use;

f) The Contractor shall design site offices for maximum daylight and minimum heat gain.

6.3.8. **Archaeological And Historic Resources**

a) If any archeological and historic structure is likely to be affected, a resource protection plan shall be prepared by the Contractor in consultation with the Archaeological Survey of India (ASI) to identify and assess construction effects and seeks ways to avoid, minimize or mitigate adverse effects on such monuments;

b) The Contractor shall stop work immediately and notify the Engineer if, during construction, an archaeological or burial site is discovered. The work will not recommence until approval of the Engineer is obtained for the same.

6.3.9. **Fly Ash**

MoEFCC fly ash notification dated September 1999 and its subsequent amendments makes it mandatory for use of fly ash-based products in construction activities located within 300Km from coal or lignite based thermal power plants. The Contractor shall use fly ash as a percentage substitution of cement, in concrete for certain structures and works as prescribed in the latest amendment. The Contractor shall provide details of usage of such products to Engineer and shall maintain a detailed record of usage of Fly Ash.

6.4. Environmental Monitoring

6.4.1. **Baseline Study:** Before commencement of actual construction work, all items and parameters as specified in ESHS manual shall be monitored once as the baseline of the environmental condition prior to the construction and compared with the monitored values during the construction period;

6.4.2. **Qualification of Monitoring Agency:** Monitoring shall be conducted by MoEFCC approved or NABL accredited laboratory and approved by the Engineer;

6.4.3. **Enforcement of the Monitoring**: Monitoring plan shall be proposed in the Contractor's ESHS Management Plan and must be approved by the Engineer before commencement of the monitoring. If the monitoring results are more than baseline and standards, cause analyses and necessary counter measures shall beproposed to the Engineer in the monitoring reports;

6.4.4. **Parameters, Location and Frequency of the Monitoring:** Environmental Monitoring parameters, locations and frequency is given in following table.

Parameters, Standards, Location and Frequency of Monitoring

Parameters	Sampling Standards	Location	Frequency
Air (PM_{10}, $PM_{2.5}$)	CPCB (2011) Guidelines for the Measurement of Ambient Air Pollutants, Manual Sampling & Analyses	One representative location within each construction yard and batching plant	Monthly
		Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by theEngineer	Monthly

Parameters	Sampling Standards	Location	Frequency
		$PM_{2.5}$ In Tunnel portion	Bi weekly
Noise **Day Time** (6 AM – 10PM) L_{max}, L_{min}, L_{eq}, L_{10}, L_{90}, L_{50} **Night Time** (10PM – 6AM) L_{max}, L_{min}, L_{eq}, L_{10}, L_{90},L_{50}	CPCB (2015) Protocol for Ambient Level Noise Monitoring	One representative location within each construction yard and batching plant	Weekly
		Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by the Engineer	Weekly
Vibration (in mm/s orVdB)	IS 14884 (2000)	During complaints or as directed by employer.	
Drinking/GW (pH, Total Alkalinity, Electrical Conductivity, Total Dissolved Solids, Fluoride, Arsenic, Nitrate, Iron, Lead, Cadmium, E-coli)	IS 3025 (2008) & IS 10500 (2012)	**Drinking water**: construction yard, batching plant andlabour camps	Quarterly (April, July, October, January)
		Groundwater: one representative tube/bore well in the adjacent residential area or within 100m from each active construction site	Quarterly (April, July, October, January)
Surface Water pH, Total Dissolved Solids, Fluoride, Arsenic, Iron, Lead, E-coli	IS 3025 (2008) & IS 2296 (1982) & CPCB (2012) Guide Manual Water and Wastewater Analysis	Upstream and downstream of the river/stream if any. Any natural water course (ex. Pond etc.) located or within 100 m of each a) construction yard, b) labour camp, and c) active construction	Quarterly (April, July, October, January)

Parameters	Sampling Standards	Location	Frequency
		site	
Waste	Not available but fully complying with monitoring the quantities of wastes specified by the Solid Management Rules 2016 & the Construction and Demolition Waste Management Rules2016	Each construction yard and construction site	Quarterly (April, July, October, January)
Hazardous waste	Not available but typed reporting (not handwriting) fully complying with monitoring the quantities of wastes specified by the Hazardous and Other Wastes (Managementand Transboundary Movement) Rules2016,	Each construction yard and active construction site	Quarterly (April, July, October, January)
Complaints if any		All Works' related locations	Weekly

6.5. Complaint Response Process

6.5.1. Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations both private and government. Most complaints are likely to be received by HRIDC, although the site offices are also likely to be contacted;

6.5.2. The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously;

6.5.3. The Contractor's Project Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Project Manager will immediately inform the Engineer;

6.5.4. Field investigation shall determine whether the complaint has merit, and if so, action shall be taken to address the complaint;

6.5.5. The outcome of the investigation and the action taken shall be documented on a complaint Performa prepared by the Contractor and submitted for notice by the Engineer in advance of the works;

6.5.6. Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days to notify the concerned person(s) that action has been taken.

6.6. Social Legal Requirement

6.6.1. The Contractor shall always comply with all relevant national and state legislations regarding social safeguard including but not necessarily limited to, the following with their latest amendments

a) National Policy for the Empowerment of Women, 2001;

b) The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013;

c) The Protection of Children from Sexual Offences Act, 2012;

d) The Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome (Prevention and Control) Act, 2017;

e) Child Labour (Prohibition & Regulation) Act 1986

Some of the key International instruments for the protection of women include the following:

a) United Nations General Assembly, Resolution 52/86 on Crime Prevention and Criminal Justice Measures to Eliminate Violence Against Women, 2 February1998;

b) United Nations Security Council Resolution 1325 on Women, Peace and Security, 31 October 2000;

c) Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016

6.7. Gender equality

6.7.1. The Contractor is responsible for providing equal opportunities to both genders and end gender related discrimination, if any. The ESHS Committee will proactively identify cases of gender discrimination with key focus on the following topics:

a) Gender based violence, including sexual harassment at the workplace;

b) Disparity in benefits provided;

c) Termination on account of pregnancy.

6.7.2. The Contractor shall enhance female workforce participation and maintain sex -disaggregated data for periodic reporting.

6.7.3. The Contractor shall ensure that women workers are paid at par with male workers

6.7.4. If women workers are deployed at site then day crèche facilities shall be provided to facilitate the women with infant working on site.

6.8. Labour Requirements

6.8.1. The contractor shall use unskilled labour drawn from local communities to avoid any additional stress on the existing facilities (medical services, power, water supply etc.)

6.8.2. The recruitment of women and members of vulnerable groups shall be prioritized

6.8.3. The Contractor shall provide training to build the skills of locally recruited labour.

6.8.4. All staff, skilled and unskilled labours employed on a site shall be required to sign Code of Conduct that shall ensure compliance with the ESHS provision of civil works and consultancy contracts.

6.9. Cultural and Religious Issues

6.9.1. Disturbance from construction works to the cultural and religious sites, and Contractors lack of knowledge on cultural issues cause social disturbances. The Contractor shall

a) Communicate to the public through community consultation, informing the peers and newspaper announcements regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction;

b) Not block access to cultural and religious sites and sites of importance for livelihood activities, wherever possible;

c) Need to take mitigation measures while working near religious place/ educational institutions close to the construction sites;

d) Provide freedom to construction workers to observe their cultural and religious practices;

e) Monitor and be responsible for the behaviour of construction workers especially migrant workers towards the community. The workers must be debriefed well regarding local aspects and need to follow good behaviours, and informed regarding unexpected behaviours at the time of employing;

f) Provision of cultural sensitization training for migrant labours regarding engagement with local community;

g) Resolve cultural issues in consultation with local leaders and Project Manager;

h) Establish a mechanism that allows local people to raise grievances (directly and

i) indirectly) arising from the construction process;

j) Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

6.10. Guidelines for Addressing GBV in Projects

6.10.1. The Contractor's ESHS Plan shall include implementation of Gender Based Violence (GBV), Sexual Exploitation and Abuse (SEA) and Sexual Harassment (SH) Prevention and Response Action Plan. This action plan shall describe Code of Conduct (CoC), mechanism to address such incidents, assess the project scenario and potential risks of GBV/SEA/SH, training plan for workers on GBV/SEA/SH and awareness programme amongst workers regarding socially, culturally appropriate behaviour that would ensure that the project community and women in particular are safe, secured, and not vulnerable to abuse. A sample GVB/SEA/SH action plan is given in Table below.

Table - GBV/SEA/SH Prevention Action Plan

Objective	Activity	Responsibility
Assess Potential Riskof GBV	Rapid assessment of worksite, project footprint (e.g.community structure, local self-governance, national regulations, history of incidence), type of workers (local or migrant) for possibleGBV risk.	As part of the social impact assessment (to be updatedat the time of construction).

Objective	Activity	Responsibility
Inclusive development	• Engaged women in project planning and implementation. • Incorporate women's feedback in project designed construction schedule. • Organize systematic consultations with women to ensure continuous feedback on projects and identify any gender-sensitive adverse impacts.	
Training – women	• Sensitization of women on GBV and women's rights to avoid/avert such incidents • Sensitization of women on actions to be taken in case of GBV	
Training – men	• Sensitization of maleworkers on GBV and women's rights to avoid/avert such incidents • Sensitization of male workers on actions to be taken in case of GBV • Sensitization of male workers on appropriate socially and culturally acceptable behaviour towards women • Training of managers on • methods of dealing with cases of GBV	
Awareness generation	• Distribution of leaflets propagating gender-appropriate behaviour • Signing of self-declaration format on commitment towards gender-sensitive behaviour	

6.10.2. The Contractor shall constitute an appropriate Grievance Redress Mechanism (GRM) for addressing grievances at worksite. Grievances of workers will be first brought to the attention of supervisor at site. Grievances not redressed by the supervisor within 7 days will be brought to the Grievance Redress Committee (GRC). The composition of GRC will have representatives from workers, women representative, ESHS staff of the Contractor ESHS staff of GC. The main responsibilities of the GRC are to: (i) provide support to workers on problems arising at worksite, (ii) record workers grievances, categorise, prioritize grievances and resolve them, (iii) immediately inform the Engineer of serious cases and (iv) report to workers on development regarding their grievances and decisions of GRC. The panel of the GRC will function without any prejudice or fear of retaliation. The well-being of the panel members will be protected by HRIDC. A format for record of complaints is given in General Instruction: ESHS/GI/008. The

GRC will redress the grievances within 14 days. The Contractor shall provide grievance box at Project site Office.

6.10.3. This project has zero tolerance of any form of:

a) **Gender-based violence (GBV)**, that is perpetrated against a person's will and that is based on socially ascribed gender-related differences between people.

b) **Sexual exploitation and abuse (SEA**) which is attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

c) **Sexual harassment (SH**) which is unwelcome sexual advances, requests for sexual favors, and other unwanted verbal or physical conduct of a sexual nature.

6.10.4. Any incidence of GBV, SEA or SH should be reported to the Grievance Redress Committee (GRC). The panel of the GRC should take appropriate gender-sensitive actions to verify authenticity of the incident with due consideration to the safety, security, and dignity of the offended person. The investigation should be concluded within three days of receiving the report or as reasonably possible. Depending on the severity of the incident, the panel may report the case to appropriate authorities.

Following the investigation, the GRC shall recommend appropriate actions to the company which may include but not limited to:

a) Informal warning

b) Formal warning

c) Additional training

d) Loss of up to one week's salary

e) Suspension of employment (without payment of salary), for a minimum period of one month up to a maximum of six months

f) Termination of employment

6.10.5. The affected person will be provided with appropriate support (e.g. psychological counselling, medical support and any other support as needed).

6.10.6. A self-declaration format for adherence to gender-sensitive behaviour should be signed by all contractors, subcontractors, employees, and senior managers, engaged by the Project to avoid GBV/SEA/SH at worksite. A self-declaration format is given in below:

6.10.7. **Commitment Statement for all Project Workers**

(to be translated into local language or explained in a manner that is appropriate forgeneral understanding of the signee)

I, (name of person), acknowledge that preventing Gender-Based Violence (GBV), Sexual exploitation and abuse (SEA) and Sexual harassment (SH) is essential, and that preventing it is my responsibility. At [Company], GBV activities constitute acts of gross misconduct and are therefore grounds for sanctions, penalties or potential termination of employment. All forms of GBV are unacceptable, be it on the worksite, the worksite surroundings, at workers' camps, or inthe community. Prosecution of those who commit GBV may be pursued if appropriate.

I agree that while working on the [Project], I will:

- Cooperate with any relevant investigations.
- Treat women, children (definition of "child" shall be as specified in Child Labour (Prohibition and Regulation) Act, 1986) and men with respect regardless of race; color; language; religion; political or other opinion; national, ethnic or social origin; sexual orientation or gender identity; disability; birth or other status.
- Not use language or behaviour towards women, children or men that is inappropriate,

harassing, abusive, sexually provocative, demeaning or culturally inappropriate.

- Not request or engage in sexual favors - for instance, making promises or favorable treatment dependent on sexual acts, in or outside the work site.
- Refrain from abusive and violent behaviour, in the workplace, labor camp or surroundingcommunities.
- Attend and actively partake in training courses related to HIV/AIDS, GBV, SEA and SH as requested by my employer.
- Report through the grievance redress mechanism or to my manager any suspected or actual GBV by a fellow worker, whether in my company or not, or any breaches of this Code of Conduct.

[Company] recognizes that false accusations of sexual harassment can have serious effects on innocent persons. If, after the investigation, it is found that the complainant has maliciously or recklessly made a false accusation, the complainant will be subject to appropriate sanctions. In such a case, the company will also take appropriate action to restore the reputation of the accused.

I understand that it is my responsibility to use common sense and avoid actions or behaviours that could be construed as GBV or breach this Self-declaration format. I do hereby acknowledge that I have read the foregoing Self-declaration format, do agree to comply with the standards contained therein and understand my roles and responsibilities to prevent and respond to GBV. I understand that any action inconsistent with this Self-declaration format or failure to act, as mandated by this Self-declaration format may result in disciplinary action and may affect my ongoing employment.

I have familiarized myself with the contents of this Self-declaration format. By my signature below, I acknowledge, understand, accept and agree to comply with the information contained in the Self-declaration format provided to me.

I hereby confirm I have read and understand the Self-declaration format.Name (Employee)

Signa
ture
Date

7. FINANCIAL DEDUCTION/WITHHOLDING

7.1. Financial deductions from Contractor on occurrences of an incident.

7.1.1. Table No. 1 below indicates ESHS incidents and the corresponding deductions to be made from the Contractor under Sub-Clauses 20.1 [Employer's Claims], Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clauses 14.6 [Issue of Interim Payment Certificates] and Sub-Clauses 14.7 [Payment] of the General Conditions of Contract.

7.1.2. The affected part of the Works shall remain suspended until all necessary investigations are completed as prescribed in Clause 2. [ESHS Management], Sub-Clause 2.15 Accident Report and Investigation and as per the related local laws of the state.

7.1.3. Upon submission of the Contractor's Request for Inspection (RFI),a joint inspection of the affected part of the Works shall be carried out by the Engineer and the Contractor. On receipt of the Engineer's Consent (Notice of No Objection: NONO), the Contractor may resume the work.

7.1.4. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with this Sub-Clause 8.5 [Extension of time for Completion]

7.1.5. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the General Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-compliance as described in this clause 7.1.

Table No. 1: Incidents

Sl. No.	Incident		Financial deductions from the Contractor in Indian Rupees
1.	Injury and Incidence reporting	i) Fatal accidents	i) Rs.1,000,000 for first fatality and Rs.1500,000 for every subsequent fatality.
		ii) Injury accident	ii) Rs.300,000 for first grievously injured person and Rs.500,000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen's Compensation Act)
		iii) Abnormal delay in reporting accidents or willful suppression of information about any accidents / dangerous occurrence as per Sub-Clause 2.15.	iii) Rs.1,00,000 for first violation and Rs.2,00,000 for subsequent violations

7.2. Withholding and deduction of payments from Contractor

7.2.1. The Engineer may issue a notice to the Contractor in accordance with Sub-Clause 3.5 [Engineer's Instruction] of the General Conditions of Contract to rectify any unsafe act or condition (including but not limited to error, default or omission) upon discovery of same on the site by the Engineer, in a form of Nonconformity Report.

7.2.2. Table No. 2 below indicates Contractor's non-conformances from the ESHS requirements of the Contract and the corresponding amounts to be withheld and deducted by the Engineer from payment due to the Contractor under Sub-Clause 14.3 [Application for Interim Payment], Sub-Clause14.6 [Issue of Interim Payment Certificates(IPC)] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract.

7.2.3. The Engineer shall have the right to withhold and deduct charges for any other unsafe act and/or condition depending upon the gravity of the situation on a case-to-case basis. The charge shall be comparable to that, which is the closest to the unsafe act/condition, indicated in Table 2.

7.2.4. Except as may be required otherwise by the Laws of the Republic of India, upon receipt of the Engineer's notification concerning an unsafe act or condition as described in Table No. 2, the Contractor shall promptly comply with such notification, investigate the cause of the unsafe act or condition and as soon as possible (but no later than 7 days, or within such other period from receipt of the Engineer's notification as may be approved by the Engineer), submit to the Engineer for review full details of the proposed correction, prevention and any other measures (hereinafter referred to as the "measures") to be taken by the Contractor to rectify and close-out the matter and to prevent re-occurrence. Such measures shall be to the satisfaction of the Engineer.

7.2.5. The Engineer is entitled to withhold amounts from the Contractor's payment until the Engineer has verified the Contractor's measures, submitted to the Engineer for review as above, and accepted them after a joint inspection in response to the RFI for the same.

7.2.6. Should the Contractor default in implementing any measures within the time previously agreed between the Contractor and the Engineer or the Contractor makes subsequent violations as specified in Table No. 2, the Engineer shall be entitled to the deduction to be recovered from the Contractor under Sub-Clause 20.1 [Employer's Claims] of the General Conditions of Contract. Such deductions shall be made via the certification and payment process provided for in the Contract, including Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clause 14.6 [Issue of Interim Payment Certificates] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract without limiting to the unsafe acts and or conditions mentioned above in Table 2.

7.2.7. The release or deduction of amount shall happen in the next payment process.

7.3. Suspension of work

7.3.1. The Engineer may issue a notice to the Contractor in accordance with Sub-Clauses 3.5 [Engineer's Instruction] and Sub-Clause 8.9 [Suspension of Work] of the General Conditions of Contract to suspend the progress of part of the Works in a form of Nonconformity Report, if in the Engineer's opinion such work is non-compliant with the ESHS requirements of the Contract. Such notification shall include details of the cause of the suspension. During such suspension, the Contractor shall protect, store and secure such part of the Works against any deterioration, loss or damage.

7.3.2. The Contractor shall not proceed with the affected Works until its measures are accepted by the Engineer.

7.3.3. Suspension of part of the Works as described in Sub-Clause 7.3.1 above and withholding of the amount from the Contractor's payment Sub-Clause 7.2 above shall continue together or independently until the Engineer has verified the Contractor's correction and close-out of any such non-conformity.

7.3.4. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with the Sub-Clause 7.2.

7.3.5. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-complianceas described in this Clause 7.

Table No. 2: Unsafe Acts/Conditions

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
1.	ESHS Management Policy & Plan	1) ESHS Policy Non-compliance of Sub-Clause 2.4.1	Rs.25,000 per month
		2) ESHS plan: i) Delay in submission (Sub-Clause 2.4.3.) ii) Not updated as per employer's instruction as per Sub-Clause 2.4.4. iii) Copies not provided to all required supervisors / engineers (Sub-Clause 2.4.5)	Rs.50,000 per month for any items i), ii) & iii)
2.	ESHS Organization	i) Not filling up the vacancies created due to ESHS personnel before leaving the Contractor (Sub-Clause 2.6.3.) ii) ESHS organization not provided with required Audio-visual and other equipment as per General Instruction ESHS/GI/ 001 (Clause 8. Attachment-4) Sub-clause-2.6.4	i) Rs.200,000 per month. ii) Rs.50,000 per month
3.	ESHS Committee	i) Failed to formulate or conduct ESHS Committee meeting for any month (Sub-Clause 2.8.1) ii) The Contractor and Subcontractor representatives not attending ESHS Committee meetings (Sub-Clause 2.8.3) iii) Failed to conduct site inspection before conducting ESHS Committee meeting (Sub-Clause 2.8.2 (h). iv) Failed to send Agenda to Employer in time or ESHS Committee Minutes of Meeting (Sub-Clauses 2.8.5 & 2.8.8.)	Deduction of amount i) Rs.100,000 per violation ii) Rs.5,000 per member not attending the meeting For item iii) & iv) Rs.25,000 per violation
4.	ID Card	i) Non-adherence of Sub-Clause 2.9.	Rs. 1,000/- per ID card per month

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
5.	ESHS Training	i) Not complying to the requirements as mentioned in Sub-Clause 2.10.1, 2.10.2, 2.10.3 & 2.10.5.	Deduction of Rs.1,00,000 per violation
6.	ESHS Inspection	i) Not complying to the requirements as mentioned in Sub-Clause 2.11. ii) Not submitting compliance report of ESHS inspection Sub-clause 2.11.5.	i) Rs.1,00,000 per violation ii) Rs. 1,00,000 per violation
7.	ESHS Audit	Internal Audit, MARS & External Audit i) Not conducted as per ESHS Plan (Sub-Clauses 2.12.3) ii) Report not sent to Employer (Sub-Clause 2.12.9) iii) Corrective action not taken for any month (Sub-Clause 2.12.9) iv) Not conducted as per ESHS plan (Sub- Clauses 2.12.10) v) Not conducted as per ESHS plan (Sub-clauses 2.12.12)	Rs.1,00,000 per violation for any item from i) to v)
8.	ESHS Communication	i) Important days to be observed for ESHS awareness as furnished by employer not observed (Sub-Clause 2.13.2) ii) Posters as directed by Employer not printed and displayed (Sub-Clause 2.13.2)	i) Rs.10,000 per violation and ii) 50,000 per month
9.	ESHS Submittals	Non-compliance of Sub-Clause 2.14	Rs.1,00,000 per month
10.	Traffic Management & site Barricading	Non-compliance of Sub-Clause 4.31	Rs.25,000 per single violation.
11.	Emergency Preparedness Plan	Non-compliance of Sub-Clause 2.16	Rs.1,00,000 per month
12.	Permit to work	Non-compliance of Sub-Clause 4.30	Rs.1,00,000 per violation.
13.	OccupationalHealth	Non-compliance of Sub-Clause 5.1 &5.2	Rs. 50,000 per month.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
14.	Labour Welfare Measures	Non-compliance of Sub-Clause 5.4	Rs.50,000 per month .
15.	Environmental Management	i) Containment of air pollution (Sub-Clause 6.3.1) ii) Containment of water pollution (Sub-Clause 6.3.2) iii) Containment of noise pollution (Sub-Clause 6.3.3) iv) Containment of waste pollution (Sub-Clause 6.3.4) v) Preservation of trees (Sub-Clause 6.3.6 (b)) vi) Environment monitoring (Sub-Clause 6.4) vii) Non-adherence to statutory agencies (SPCB, CPCB NGT etc.) environment management guidelines	Rs.50,000 per violation for any item from i) to vii) Actual penalty imposed by statutory agency
16	Housekeeping	Non-compliance of Sub-clause 4.2 & Sub- Clause 6.3.5 i) Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained ii) Office, stores, toilet / urinals not properly cleaned and maintained. iii) Required garbage bins at appropriate places not provided / not cleaned. iv) Stairways, gangways, passageways blocked. v) Lumber with protruding nails left as such vi) Openings unprotected vii) Excavated earth not removed within a reasonable time.	Rs.50,000 per violation for any item from i) to xii)

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		viii) Truck carrying excavated earth not covered/tyres not cleaned. ix) After close of work Vehicles / equipment not parked at designated place x) Unused surplus cables / steel scraps lying scattered xi) Wooden scraps, empty wooden cable drums lying scattered xii) Water stagnation leading to mosquito breeding	
17.	Working at Height / Ladders and Scaffolds	Non-compliance of Sub-Clause 4.3.	Rs.50,000 per violation
18.	Lifting Appliances and Gear	Non-compliance of Sub-Clause 4.6	Rs.50,000 per violation
19.	LaunchingOperation	Non-compliance of Sub-Clause 4.7	Rs.50,000 per violation
20.	Construction Machinery	Non-compliance of Sub-Clause 4.8	Rs.50,000 per violation
21.	Site Electricity	Non-compliance of Sub-Clause 4.10	Rs.10,000 per violation.
22.	Power Tools	Non- Compliance of Sub-Clause 4.10.20	
23.	Welding and Cutting	Non-compliance of Sub-Clause 4.12 i) Wrong colour coding of cylinder. ii) Cylinders not stored in upright position. iii) Flash back arrester, non-return valve and regulator not present or not in working condition. iv) Fail to put cylinders in a cylinder trolley. v) Damaged hose and fail to use hose clamps	Rs. 10,000 per violation for any item from i) to xiii)

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		vi) Using domestic LPG cylinders vii) Fail to store cylinder 6.6m away from fire prone materials viii) Fire extinguisher not placed in the vicinity during operation Voltmeter and Ammeter not working. ix) Non-availability of separate switch in the transformer x) Improper grounding and return path. xi) Damaged and bare openings in the welding cable. xii) Damaged holder xiii) Fire extinguisher not placed in the vicinity during operation	
24.	Fire Precaution (Clause 4.27)	i) Smoking and open flames in fire prone area ii) Using more than 24V portable electrical appliances in the fire prone area iii) Not proper ventilation in cylinder storage area. iv) Absence of fire extinguishers v) Fire extinguishers not refilled once in a year. vi) Fire extinguisher placed in a not easily accessible location	Rs. 10,000 per violation for any item from i) to vi)
25.	Excavation, Tunneling and Confined Space	Non-compliance (Sub-Clauses 4.13, 4.14, 4.26)	Rs. 10,000 per violation
26.	Batching plant and Casting yard	Non-compliance of Sub-Clause 4.18	Rs. 10,000 per violation.
27.	Personal Protection Equipment	Non-compliance of Sub-Clause 4.34. Items of attention are as under – i) Not having ii) Not wearing (or) using and kept	Rs. 200 per person per violation for any item from i) to vi)

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		it elsewhere. iii) Using damaged one iv) Using wrong type v) Using wrong colour helmet or helmet without logo vi) Using for other operation (e.g. Using safety helmet for storingmaterials or carrying water from one place to other)	
28.	Working near Railway	Non-compliance of Sub-Clause 4.32.	Rs. 1,00,000 per violation

8. ATTACHMENT

Attachment -1 Contents of ESHS Management Plan

1.0 General

1.1 The Contractor shall prepare an Environment, Social, Health and Safety (ESHS) Management Plan, which provides measures to protect the Environment, Health and Safety of workers and the public.

1.2 The Contractor’s ESHS Management Plan shall be based on Environment, Social, Health and Safety considerations submitted with the Tender and shall have the content shown in the following section [Contents of ESHS Management Plan].

1.3 The Contractor shall submit his ESHS Management Plan for review by the Engineer within 28 days after the Commencement Date and shall amend the ESHS Management Plan to address any comments made by the Engineer and submit a Final ESHS Management Plan within 14 days of receipt of comments.

1.4 The Final ESHS Management Plan shall be binding on the Contractor for the duration of the Contract.

2.0 Content of ESHS Management Plan

2.1 The Contractor’s ESHS Management Plan shall cover the following aspects:

Site ESHS Management Plan	
Contract No.	
Contractor Name	
Project Name	
1	Project Highlights i) Title of the content; ii) Contract number; iii) Brief scope of work; iv) Location map/key plan; v) Period of the project;
2	ESHS Management Policy with senior management responsibility;
3	Site organization chart Chart indicating reporting of ESHS Management personnel, appointment, duties, and responsibilities
4	Roles &responsibility Individual responsibility of the i) The Contractor’s representative ii) ESHS Manager iii) Environment manager iv) Social expert

	v) Chief accident prevention officer vi) Construction manager vii) Construction Supervisors viii) ESHS Committee members ix) ESHS in charge x) Site engineers xi) First line supervisors xii) Subcontractors
5	ESHS site Committee xiii) Details - Chairman, secretary, members, and employer’s representative xiv) Procedures for effective conduct of meeting
6	ESHS Training
7	Subcontractor Safety and Health procedures for Subcontractors;
8	ESHS Inspection and audit
10	Accident, diseases investigation reporting procedures
11	Health, First Aid, and emergencies measures
12	Staff and labour welfare measures at site
13	Policy for identifying hazards and risks with risk assessment and mitigation procedures
14	Safe Work Procedures e.g. i) Excavation ii) Structural steel erection iii) Form works iv) Concrete placement v) Work at height vi) Switch-over works vii) Floor, wall openings and stairways viii) Welding, cutting and bracing ix) Lifting appliances x) Electrical equipment xi) Mechanical equipment xii) Fire prevention xiii) Hazardous chemicals and solvent xiv) Lighting xv) Abrasive blasting

15	Work permit system
16	List of standard job specific PPEs to be used in the site
17	Maintenance of regime for construction equipment and machinery
18	Traffic management
19	Housekeeping
20	i) Environmental and Social Management ii) Applicable National and State legislation and regulations iii) Specific procedures for achieving environmental and social performance requirements as given in the Employer's requirements on Environment. iv) Details on air monitoring and noise monitoring control plan which details mitigation measures / corrective action / preventive action and monitoring schedule. v) The ESHS Management Plan must contain procedures on prevention and control of water pollution, storage, handling and disposal of waste, including municipal, C&D, plastic, bio-medical, chemical and hazardous wastes, reuse/recycle of waste, selling to authorised recyclers and records thereof, preservation of landscape disturbed due to construction, housekeeping/Environmental sanitation and traffic management as required under the contract. vi) Procedures for recording environmental complaints and response process. vii) HIV prevention and control plan viii) Gender Based Violence (GBV) and sexual Exploitation and Abuse (SEA) prevention and response plan ix) COVID-19 Response and management plan
21	Visitors and security arrangement
22	Disciplinary Procedures
23	Safety and Health promotion and awareness;
24	Safety and Health equipment and Safety and Health of the Contractor's construction and office equipment;

Note: -The Environment, Social, Health and Safety (ESHS) Management Plan shall be incorporated in the relevant sections.

3.0 Training

3.1 The Contractor shall describe the training program and content he will provide for workers and staff to:

a) Raise awareness of the role and importance of Environment, Social, Health and Safety matters; the potential negative impacts of construction work in general and the ways in which impacts can be prevented; and the expected construction impacts and long-term environmental and social benefits of the applicable project;

b) Disseminate the philosophy and approach of the ESHS Management Plan throughout the workforce, and explain the roles of all parties in implementing the ESHS Management Plan; and

c) Inform all employees of the Environment, Social, Health and Safety activities they are required to comply with when conducting their work, and the penalties for non-compliance.

3.2 Training to raise the awareness and capacity of the Subcontractors and their employees shall also be incorporated where necessary.

3.3 The Contractor shall prepare the following plans to supplement the ESHS Management Plan:

a) Emergency Response Plan; and

b) Fire Evacuation Plan.

Attachment -2 Workplace Policy (on HIV/AIDS Prevention & Control)

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recognizes HIV/AIDS as a developmental challenge and realizes the need to respond to it by implementing regular HIV/AIDS prevention programmes and creating a non-discriminatory work environment for HIV infected workmen engaged by Contractors. For the purpose of making conscientious, sensitive and compassionate decision in addressing the realities of HIV/AIDS, HRIDC has established these guidelines based on ILO code of practice on HIV/AIDS.

- Creating awareness through professional agency using IEC (Information, Education and Communication) package specially designed for migrant workers.
- Institutional capacity building by training the project implementation team, Environmental, Social, Health & Safety (ESHS) Managers, establishing linkages for deficient diagnosisand treatment of the affected workers, effective monitoring of implementation and documentation for further learning.
- Establishing peer educators by selecting them in consultation with Contractors and training them through professional agencies so that they become focal point for any information, education and awareness campaigns among the workmen throughout the contract period.
- Promotion of social marketing of condom

Attachment -3 Work Place Policy on COVID-19 Prevention and Control

It is likely that Corona virus Disease 2019 (COVID-19) will continue to occur in the community in the foreseeable future. It is therefore necessary to have a plan/policy in place to prevent the spread of this virus within the workplace. In order to reduce the risk of infection, Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recommends to the Contractor to consider the following measures:

a) The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site.

b) On day 0, before resuming the work on sites post lockdown period, mandatory medical check-up will be arranged for all workers.

c) The workers coming from outside shall observe home-quarantine for at least 14 days as per the guidelines issued by MoHFW.

d) Only medically fit workers will be deployed at site and medical assistance will be arranged for unfit workers.

e) A unique photo identity card with serial number will be issued to all the workers and their family members staying at site.

f) All the essential items will be made available to them at site only. If necessary, they can go out wearing face masks, after informing the supervisor.

g) No outside worker will be allowed to stay at site without following proper procedure and instructions.

h) Start time on site will be staggered to avoid congestion at the entry gates.

i) As in most cases, workers reside at the sites, hence no travel arrangements are required for them.

j) The workers staying outside (which are always nearby) shall reach the site either by walking or by their individual mode of transport (bicycle, two-wheeler etc.).

k) During attendance, training and other sessions, social distancing guidelines will be followed along with provision of no-touch attendance.

l) All workers may be advised to take care of their own health and look out for respiratory symptoms/fever and, if feeling unwell, shall leave the workplace immediately after informing their reporting officers.

m) They shall observe home-quarantine as per the guidelines issued by MoHFW and shall immediately inform the nearest health centre or call 011-23978046.

n) Workers shall not shake hands when greeting others and while working on the site.

o) Mandatorily wear face masks while working on site. While not wearing masks, cover your mouth and nose with tissues if you cough/sneeze or do so in the crook of your arm at your elbow.

p) Avoid large gatherings or meetings. Maintain at least 1 metre (3 feet) distance from persons, especially with those having flu-like symptoms, during interaction.

q) Not more than 2/4 persons (depending on size) shall be allowed to travel in lifts or hoists.

r) Use of the staircase for climbing shall be encouraged.

s) Workers shall clean hands frequently by washing them with soap and water for at least 40 seconds.

t) Workers shall not share their belongings like food, water bottles, utensils, mobile phones etc. with others.

u) The utensils shall be washed properly post use at designated places.

v) Post work, workers shall change their clothes before leaving the site and clothing shall not be shook out.

w) Avoid touching your eyes, nose, or mouth with unwashed hands.

Attachment -4 Reference for ESHS Activities

General Instruction: ESHS/GI/001

Minimum Requirements of ESHS Monitoring and Audio-Visual Equipment’s

a) Every Contractor shall provide the following audio-visual aids for conducting weekly review, monthly safety committee and other post review meeting of all fatal and major incidences effectively. This audio-visual equipment is a must for conducting periodical in-house safety presentations in the training programs; and

b) In addition to the above, portable hand held Type I or Type II digital sound level meter (SLM) and portable hand held digital Lux meter are also to be provided.

c) The minimum requirement of the quantity to be provided in ESHS management Plan and approved by the Engineer.

Sl. No	ESHS Monitoring and Audio-Visual Equipment details
1.	Portable hand-held Type I or Type II Digital Sound Level Meter (SLM)
2.	Portable hand-held Digital Lux Meter
3.	Laptop computer with standard configuration including multimedia facilities
4.	Colour printer
5.	Computer projector with screen
6.	Overhead projector
7.	Smartphone for taking photos and recording of video
8.	Portable loudspeaker (for tool-box talk and emergency purpose)
9.	Communication facility like mobile phone, walky-talky etc.
10.	Accident investigation Kit containing the following:
a)	Chalk piece for marking
b)	Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m
c)	Equipment tags
d)	Multipurpose Flash light
e)	Barrier tape
f)	Accident investigation Forms and checklists
g)	Enough Paper for witness recording and other noting
h)	Emergency Phone Numbers list

General Instruction: ESHS/GI/002

Topics for ESHS Orientation Trainings for Workmen for First Day at Work

1) **Hazard Identification Procedure**

Hazards on site:

- Falls;
- Earthing work;
- Electricity;
- Machinery;
- Handling materials;
- Transport;
- Site housekeeping;
- Fire;
- Safety of nearby located structures;
- Works close to railway tracks or roads.

2) **Personal Protective Equipment**
- What is available?
- How to obtain it?
- Correct use and care.

3) **Health**
- Site welfare facilities;
- Potential health hazards;
- First Aid/Cardiopulmonary Resuscitation (CPR). /Automated Externaldefibrillator (AED)

4) **Duties of the Contractor**
- Brief outline of the responsibilities of the Contractor by law;
- Details of the Contractor's accident prevention policy;
- The Employer ESHS Management Manual (if any);
- Building and other Constructions Welfare Law.

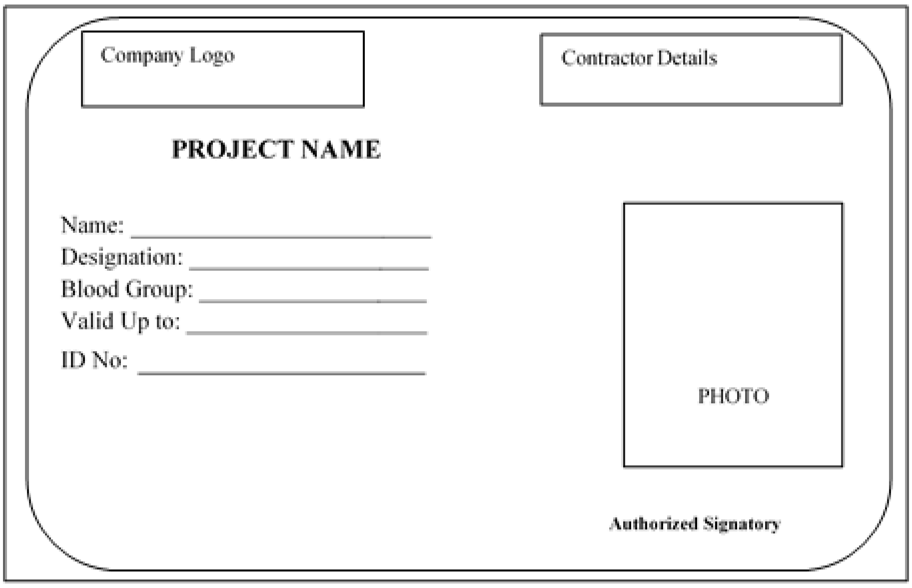
5) **Employee's Duties**
- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accidentprevention (induction and orientation).

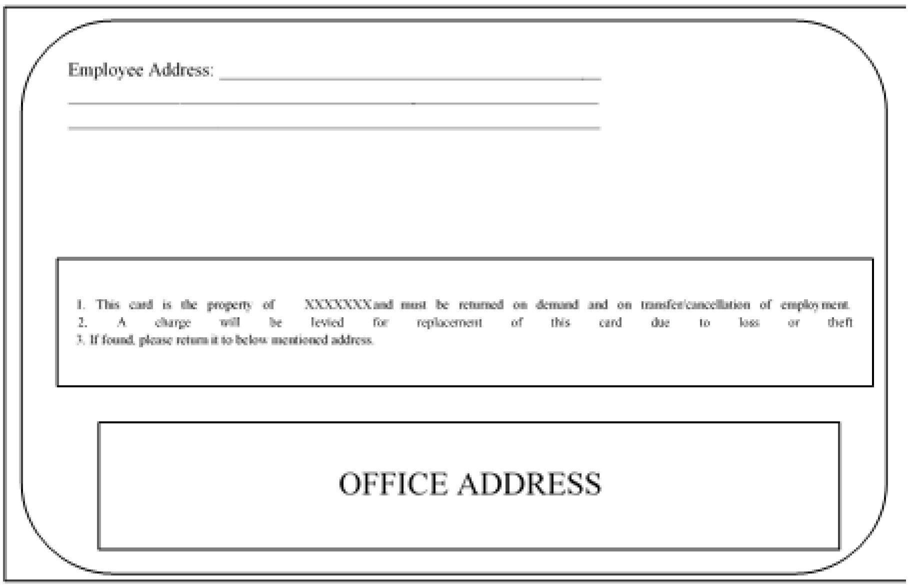
6) **Environment And Social**
- Contractor's Environment Policy
- Key legal requirements
- Avoidance of Nuisance
- Environmental Sanitation
- Dust Control Measures
- Water Pollution and Control
- Occupational noise mitigation

- Waste Management and Disposal
- Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA)
- HIV/AIDS prevention
- Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/003

ID CARD FORMAT (85 mm x 55mm) FRONT SIDE OF ID CARD:





General Instruction: ESHS/GI/004 [ESHS Training Matrix]

ESHS Supervisors	ESHS Manager	Medical Officer	Clerical Staff	Security Officers	Transportation Drivers	Electrical workers	Mechanical Workers	Steel Workers	Station Building Workers	Material Handlers	Machinery Operators	Construction Foreman	Construction Supervisors	Construction Managers	Planning Engineer	Quality Manager	Sr. Construction Managers	Contractor Representative	Types of Training
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS orientation
		*												*	*	*	*	*	ESHS leadership
*	*	*										*	*	*	*	*	*	*	ESHS plan
*	*												*	*		*	*	*	ESHS improvement plan
*	*												*	*	*	*	*	*	Management of change
*	*												*	*	*		*	*	ESHS audit and inspection
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS emergency response & preparedness
*	*	*		*									*	*	*	*	*	*	Incident/Accident investigation & reporting
*	*											*	*	*	*	*	*	*	ESHS communication
*	*													*	*		*	*	ESHS promotion & incentives
*	*			*	*						*		*	*		*	*	*	Traffic management
*	*			*						*		*	*	*	*	*	*	*	Hazard identification & risk analysis & Aspect Impact
*	*			*				*	*	*		*	*	*		*	*	*	Permit to work system
*	*													*	*	*	*	*	Confined space entry
*	*	*		*				*	*	*				*		*	*	*	Scaffolding
*	*	*	*	*	*	*	*	*	*		*		*	*		*	*	*	Waste management
*	*											*	*	*			*	*	Environment monitoring
*	*	*										*	*	*		*	*	*	Labour welfare measures
*	*											*	*	*		*	*	*	Behavior Based Safety Management (BBSM)
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	Industrial First Aid and CPR
*	*		*	*	*	*	*	*	*	*	*	*	*						Fire fighting
*	*					*	*	*		*	*	*	*	*			*		Rigging
*	*											*	*	*					Wire rope inspection
*	*											*	*	*					Crane inspection
*	*											*	*	*					Electrical/Mechanical isolation
*	*											*	*						Explosive handling and control
*	*					*	*	*	*			*	*						Heavy lifting operation
*	*							*				*	*						Welding, cutting and bracing
*	*								*			*	*						Power actuated hand tool
*	*					*	*	*	*			*	*						Roofing work
*	*							*				*	*						Steel erection work
*	*					*	*	*	*			*	*						Scaffold erection/dismantling

General Instruction: ESHS/GI/005

<u>ESHS Training Details for Managers and Supervisors</u>

1. The Law and Safety	**2. Policy and Administration**
Statutory requirement Appropriate regulations Duties of employee	Effect of incentive on accident prevention ESHS Policy Industrial relations Safety Officer: duties, aims, objectives
3. Safety and the Supervisor	**4. Principles of Accident Prevention**
Safety and efficient production Accidents affect morale and public relations	Attitudes of management, supervision and operations Methods of achieving safe operations Accident and injury causes
5. Site Inspection	**6. Human Behaviour**
The role of management Hazard Identification Procedure Records results Follow-up procedures Feedback	Motivating agencies Individual behaviour Environmental effects Techniques of persuasion
7. Site housekeeping	**8. Health**
Site organization Relationship of site housekeeping to accident occurrence Site access Equipment storage Material stacking Materials handling	Medical examination Hazard to health on site Sanitation and welfare Protective clothing First Aid/CPR
9. Personal Protective Equipment	**10. Electricity**
Eye, face, hands, feet and legs Respiratory protective equipment Protection against ionizing radiation	Appreciation of electrical hazards Power tools Arc welding Low voltage system Lighting and power system on sites ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs)
11. Oxygen and Acetylene Equipment	**12. Equipment**
Cylinder storage and maintenance Condition and maintenance of valves, regulators, and gauges Condition and maintenance of hoses and fittings Pressures	Accidents related to moving parts of machinery Appreciation of principles of guarding Importance of regular maintenance

13. Transportation Transport to and from site Hazard connected with site transport Competent drivers Dumpers Tipping trucks Movement near excavations	**14. Excavations** Method of shoring Precautions while shoring Precautions at edge of excavations Removal of shoring Sheet steel piling
15. Working platforms, Ladders, and Scaffolding	**16. Cranes and other Lifting Machines**
Hazards connected with the use of ladders Maintenance and inspection Type of scaffold Overloading Work on roofs Fragile material Openings in walls and floors Use of Full Body Harness and nets	Licensing, certification and training required for operation of cranes Slinging Methods Signalling Access to crane(s) Maintenance and examination Ground conditions Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment Crane Lift Plan for all lifts
17. Lifting Tackle	**18. Fire Prevention and Control**
Slings - single and multi-legged Safe working loads (SWLs) Safety hooks and eyebolts Cause of failure Maintenance and examination	Principle causes determining fire Understanding fire chemistry Firefighting equipment Firefighting training
19. Communications	
Effective methods of communication (interest to non-English speaking workers) Method and preparation of reports Safety committees Safety meeting	

20. **Environment and Social**

Environment Policy Regulatory requirements • Central • State • Judicial • Environmental requirements of funding agency Overview of Environmental issues at construction sites and funding agency's requirements. Avoidance of nuisance Environmental sanitation Dust control measures Overview of impact of construction on Climate change Contractual requirements to reduce construction related impacts Monitoring of environmental parameters and their significance Waste Management Occupational Noise and its mitigation Health impacts of construction industry Resource minimization ISO requirement (as applicable) Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA) HIV/AIDS prevention Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/006

WEEK/DAYS TO BE OBSERVED FOR CREATING ESHS AWARENESS

1st Monday to Sunday of January	Road Safety Week (Subjected to confirmation from Ministry of Road Transport, Govt. of India every year.)
16th February	Kyoto Protocol Day
March	Red Cross Month
4th March	National Safety Day
22ndMarch	World Water Day
7th April	World Health Day
14th April	Fire Safety Day
18th to 22nd April	Earth Week
20th April	Earth Day
20th April	Noise Awareness Day
28th April	ILO World Day for Safety and Health at Work Day
1st to 7th May	Emergency Preparedness Week
5th June	World Environmental Day
12th June	World Day against Child Labours
21st June	World Yoga Day
9th July	Occupational Health Day
17th October	World Trauma Day
1st December	World AIDS Day

General Instruction: ESHS/GI/007

Minimum Requirements of ESHS Communication Posters/Signage/Video:

a) Every Contractor shall prepare a ESHS Communication Plan as a part of site specific ESHS Management Plan and shall include the following minimum requirement of Posters/Signage/Video as applicable. In case readymade posters are available in any of the category from National Safety Council or any other safety related organizations they may procure the same and display it. In case the same is not available, then the Contractors shallmake necessary arrangements to get the posters designed and printed on their own. All posters shall each be in Hindi, English and the regional language; and

b) All the above is to be detailed in the Contractor's ESHS Management Plan and he shall obtain the Engineer's prior consent for the numbers, contents, locations, etc.

Table No.: 1 - Minimum No. of Posters

Sl. No	ESHS Poster Title	Minimum No. of concepts in each title	No. of Posters/Signage/Video
1.	Safety Culture	5	Each 10
2.	Daily Safety Oath	1English, 1 Hindi	Each 50
3. a)	Signage to display the messages like PPE ZONE, NO PPE ZONE, HARD HAT AREA etc.	2 types of sizes made up of metal sheet to be mounted at different locations	Each 25
b)	Helmet	5	Each 25
c)	Shoe	5	Each 25
d)	Goggles & Ear Protection	5	Each 25
e)	Full Body Harness	5	Each 25
f)	Hi-Vi Jacket	5	Each 25
4.	Emergency Management Plan	5	Each 25
5.	Working at Heights	10	Each 25
a)	Ladder, Stairway, Scaffold - Signage to display the messages like SAFE, UNSAFE, FIT FOR USE, AVOID USE etc.	5 types of sizes made up of metal sheet to be mounted at different locations	Each 25
6.	Site Electricity	5	Each 25

7.	Crane Safety	5	Each 25
8.	Slings	5	Each 25
9.	Rigging Procedures	5	Each 25
10.	Excavation	5	Each 25
11.	Occupational Health (Mosquito Control, HIV/AIDS awareness, Dust Control, Noise Control, No Smoking/Spitting, etc.)	10	Each 25
12.	First – Aid	3	Each 25
13.	Labour Welfare Measures (Payment of Minimum Wages, Avoidance of Child labour, signing in the Muster Roll, in case of accidents-what to do? Etc.	5	Each 25
14.	Importance of “Safety Handbook”	1	25
15.	Traffic Safety (Speed limit, safe crossing and working within barricaded area etc.)	5	Each 25
16.	Environmental Monitoring (Spillage of Muck, hazardous material, Improper drainage, water spray for dust containment etc.)	5	Each 25
17.	Video in Hindi on PPE usage – 15 minutes duration	1	-

Note 1: Items mentioned under 17 is video. Items under 3 (a) and 5 (a) are metal signage boardsand all other items are posters.

Note 2: The above minimum numbers are for guidance only. The actual number will depend on

the project’s specific requirements. The Contractor shall propose and obtain Engineer’s priorconsent to the final numbers, locations, etc.

Table No.: 2 – Size of Posters/Signage

Sl. No	Item	Size

1.	Posters – Standard	17"x22" –135 GSM 4 Colour Printing
2.	Posters – Special (Wherever required)	17"x22" card laminated FA Poster
3.	Posters - Mega size (Wherever required)	32"x40" Flex FA Poster
4.	First-Aid Booklet	6"x4"
5.	Safety Handbook	6"x4"
6.	Signage	Small: 12"x6" Big: 24"x12"
7.	Road Traffic Sign Boards	Strictly as per Indian Road Congress (IRC) specifications

Table No.: 3 – Safety Signage Colour (as per IS: 9457)

Sl. No	Type of signage	Colour
1	Mandatory	Blue
2	Danger	Yellow
3	Prohibitory	Red
4	Safe conditions	Green

_

General Instruction: ESHS/GI/008

Environment, Social Formats/Checklist

1. Weekly Environmental Inspection Summary

1.0 Major issues of non-conformity in the past week are:

Issue

Rea

son

I. Air (Specify)
II. Water (Specify)
III. Noise (Specify)
IV. Water (Specify)
V. Storage (Specify)
VI. Housekeeping (Specify)
VII. Roads (Specify)

2.0 Over the last week have been able to implement environmental management requirement asper contract

Yes ☐ No if not yes reasons are:
(i)
(ii)
(iii)

3.0 Following issues have not been resolved for more than past two weeks
(i)
(ii)
(iii)

4.0 Support/Clarification from Employer's Representative required in the following:
(i)
(ii)
(iii)

5.0 Complaint received in the past week:

From	Action Taken	Reasons for Delay
(i) Public		
(ii) Client		
(iii)Statutory Agency		

Auditor: Project Manager

Contact Number: Contractor:

Environmental Manager	**Project Manager**	**Document No.:**

2. Weekly Environmental Inspection

Report No.:	Inspection Date:	Inspected by:
Inspection Area:		
Participants:		

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
1.0	**Air Pollution**				
1.1	Dust (approach roads, adjacent road, working area, cement handling etc.)	☐ Satisfactory ☐ Site Dusty ☐ Sprinkling carried out as required ☐ Excavated soil removed within 2 days			
1.2	Generators	☐ Satisfactory ☐ Maintenance regime followed ☐ Black smoke ☐ Leaking oil ☐ Drip pans not available			
1.3	Vehicles	☐ Satisfactory ☐ PUC certificate available ☐ Black smoke ☐ Wheel washed/cleaned ☐ Leaking oil ☐ Side of vehicle clean of mud ☐ Material transported in closed manner			
1.4	Air monitoring	☐ Carried out as per contract ☐ Results reported as per contract			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
		☐ Remedial measures in place where required			
2.0	**Water Pollution**				
2.1	Site Drains	☐ Drainage system functional ☐ No Contamination ☐ Not blocked by debris/ garbage ☐ No indications of Oil spilled in drains ☐ Storage of chemical waste not nearby			
2.2	Adjacent Drains	☐ Not damaged ☐ No signs of pouring bentonite ☐ No signs of pouring Chemicals ☐ Signs of discharging Silt/ debris			
2.3	Separator Tanks	☐ Tank not full of silt ☐ Tank regularly emptied			
3.0	**NOISE POLLUTION**				
3.1	Noise control measures	☐ All powered mechanical equipment's are sound reduced ☐ Acoustic / enclosures constructed in areas of excessive noise ☐ Equipment located and directed away from noise receptors			
3.2	Generators provided with acoustic enclosures	☐ Effective ☐ Not effective ☐ Not provide			
3.3	Noise Monitoring	☐ Carried out as per contract ☐ Not exceeded baseline values ☐ Remedial measures in place ☐ Results evaluated statistically for inclusion in Monthly report			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
4.0	**WASTE MANAGEMENT**				
4.1	Waste Identified	☐ Chemical Flammable Corrosive Construction related/ oil/ Filters/ Batteries ☐ Hazardous ☐ Other (Specify)			
4.2	Storage Containers & Bins	☐ Adequate number and properly place ☐ Proper quality ☐ Emptied regularly ☐ Labelling proper ☐ No spillage on container ☐ surface noticed			
4.3	Storage Containers & Bins	☐ Pollutants (e.g. waste chemical), not dumped in bins ☐ Recyclable (e.g. metal) not dumped in garbage bins			
4.4	Oil Waste	☐ Drip pans available ☐ No oil stains on ground ☐ Spill absorption material available ☐ Waste oil poured in to designated waste drums ☐ Used oil filters not dumped in garbage bins			
4.5	Excavated soil	☐ Storage satisfactory/ properly secured ☐ Dumping in authorized areas ☐ No interference with nearby drainage			
5.0	**STORAGE**				
5.1	Diesel Storage	☐ Extensive diesel spillage on ground not visible ☐ Drip pans used when pumping diesel ☐ Pipes / connectors/ pumps not leaking			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
		☐ Not located close to storm water drains ☐ Transfer arrangement satisfactory			
6.0	**AESTHETICS & CLEANLINESS**				
6.1	Housekeeping & Hygiene	☐ Designated storage area for materials ☐ Scraps/brickbats/rubbish scattered at site ☐ Proper space for handling waste ☐ Area Clean and dry ☐ Stagnant water treated weekly ☐ Proper stacking of drums ☐ Barricades are clean, in line, firmly secured and proper earthling ☐ Water not allowed to accumulate in work area for any reason			
7.0	**Roads**				
7.1	Access Roads	☐ Satisfactory Maintenance ☐ In urgent need of Maintenance			
7.2	Public Roads used by Contractor	☐ Satisfactory maintenance ☐ Repair not carried out			

3. Air and Noise Monitoring Report Format

Air Monitoring Report

Parameter:
Unit :

CPCB Standard Value:

Location	Monitoring Date	Measured Value	Base line value if any

Noise Monitoring Report
Day Time

Location	Category of Area/Zone	National Standard (Day time) Leq dB(A)	Baseline value (Day time), Leq dB(A)	Noise levels (Day time) Leq dB(A)

Night Time

Location	Category of Area/Zone	National Standard (Night time) Leq dB(A)	Baseline value (Night time), Leq dB(A)	Noise levels (Night time) Leq dB(A)

4. Monthly Waste Management Record

S.No	Waste Type	Unit	Quantity Generated		Quantity Disposed off		Adopted/Proposed disposal method
			For the month	Till date	For the month	Till date	
1	**Construction and Demolition Waste**						
	a. Concrete waste	MT					
	b.Demolition Waste	MT					
	c. Bentonite/Polymer mixed soil	CUM					
	d. Good earth	CUM					
2	**Hazardous Waste**						
	a. Waste oil	Litres					
	b. Oil filters	Nos					
	c. Air filters,	Nos					
	d. Cartridges etc.	Nos					
	e. Other (if any)						
3	**Recyclable waste**						
	Paper, plastic, wood, bottles, rubber etc.	Kg					
4	**Bio-degradable waste**						
	Food waste, vegetable waste etc	Kg					
5	**Metal Scrap**	Ton					
6	**E -Waste**	Nos/ Ton					
7	**Miscellaneous (any other)**						

Prepared by:	**Reviewed by:** **(Environment Manager)**	**Approved by:** **(Project Manager)**

5. Water Consumption Details

S. No	Source of Water	Quantity Consumed for the month (KL)	Quantity Consumed till date (KL)
1	Ground Water Extracted		
2	Municipal Supply		
3	Water Tanker		
4	Water bottles		
Total (A)			
Breakup of Raw Water Consumption Detail			
S. No.	**Particular**	**Quantity Consumed for the month (KL)**	**Quantity Consumed till date (KL)**
1	**Raw Water**		
	a. Consumed in RO Plant		
	b. Sprinkling		
	c. Wheel washing		
	d. Domestic purpose like drinking, toilets, labour camps, office cleaning		
	e. Curing		
	f. Stone cutting		
	g. TM washing		
	h. Any other use		
	Total (B)		
2	**R O treated water**		
	Total (C)		
3	**R O Reject Water**		
	Total (D)		

Prepared by:

Reviewed by:
Environment Manager

Approved by:
Project Manager

6. Details on Fly Ash (If Applicable)

The Employer shall give his consent to the civil Contractor for using Fly Ash in concrete or brick works. The Contractor shall record all relevant details on the consumption of Fly Ash from the data of initial consumption to date of final use.

Fly Ash utilization in tonnes in Building Materials and Products for the FY-
Contract No. :
Name of Contractor :
Details regarding utilization of fly ash in road/flyover construction projects:

S. No.	Item of work	Total quantity of material used (tonnes)	Quantity of Fly ash used (tones)	Quantity of Soil/Earth any other material used (tones)	% fly ash used against total quantity of material used	Source of fly ash
Remarks:						

Prepared by:

Reviewed by:
Environment Manager

Approved by:
Project Manager

7. Material Consumption Details

S.No.	Particular	Unit	Quantity Consumed	
			For the month	Till date
1	Concrete	CUM		
2	Cement	MT		
3	Sand	MT		
4	Coarse Aggregate	MT		
5	Reinforcement	MT		
6	Admixtures	Litres		
7	Diesel	Litres		
8	Electricity	kWh		

Prepared by:	Checked by: (Environment Manager)

8. Records of Complaints

S.No	Nature of Complaints	Date of Complaints Received	Impact Location	Name of Complainant	Address of Complainant	Remarks	Status		
							Solved	On going	Pending

General Instruction: ESHS/GI/009

MARS Audit Rating

Contractor No.:	Contractor:	
Audit No.:	Date:	
For the month of:		
Audit team	Contractor representatives	HRIDC/GC Representatives
Headed by:		
Assisted by:		

Contract No.:		Contractor:	
For the month of:			
Audit date:			
Sl. No.	Section	% score attained By Contractor	% Score given By HRIDC-GC
1	ESHS Administration		
2	ESHS Training and ESHS Communication		
3	ESHS Inspection and Audit		
4	Hazard Identification, Risk Assessment and Emergency Preparedness		
5	Reporting of Accidents and Dangerous Occurrences and investigations		
6	Housekeeping		
7	Working at Height		
8	Lifting Operations and Gears		
9	Construction Machinery / Hand tools and power tools		
10	Site Electricity		
11	Fire prevention		
12	Welding & Cutting		
13	Excavations and Trenching		
14	Tunnelling and Confined Space operations		
15	Traffic management		
16	Personal Protective Equipment		
17	Industrial Health & Hygiene and Lighting & Ventilation		
18	Welfare amenities		
19	Environmental management		
20	Batching Plant and Casting Yard		
Overall audited score attained			

Team Head / Contractor Name:	**Designation**	**Signature**	**Date**
Team Head / HRIDC/GC Name:	**Designation**	**Signature**	**Date**

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

1.0 ESHS Administration

1.1 ESHS Organisation	**A**	**B**	**C**	**1.1a ESHS Organisation**	**A**	**B**	**C**
Adequacy of ESHS personnel	10			ESHS manpower from outsourcing agency	10		
Is ESHS personal professionally qualified	10			ESHS personals reports to ESHS manager	10		
Employer's approval for each ESHS personal	10			ESHS manager reports to Project Manager	10		
Intimation of ESHS personals vacancy to Employer	10			Facilities and equipment gave to the ESHS personnel	10		
ESHS personal lies with the main contractor	10			ESHS personnel can stop any unsafe act	10		
Sub total	**50**			**Sub total**	**50**		
1.2 ESHS Committee	**A**	**B**	**C**	**1.3 Construction ESHS Committee**	**A**	**B**	**C**
Is site and construction ESHS Committee formed	10			Does construction ESHS committee meet at least weekly	10		
Does PM Chairman of ESHS Committee	10			Do all sub contractors attend	10		
Committee members under gone monthly inspection	10			Is agenda cover all the points	10		
Does site ESHS committee meet at least monthly with 21 days time gap	10			Minutes of the meeting send to all committee members	10		
Are Incident Reports discussed	10			Minutes displayed in the notice board	10		
Sub total	**50**			**Sub total**	**50**		
1.4 ID card and first day at work	**A**	**B**	**C**	**1.5 Designer's role**	**A**	**B**	**C**
Is ID card issued to all persons	10			Whether designers were informed about clause 5.0 of Conditions of Contract on ESHS	10		
Is ID card as per standard	10			Whether designers provide ESHS risk at the drawing itself.	10		
Authority signed all ID cards	10			Whether hierarchy of risk control is indicated by the designer	10		
All worker undergone orientation training	10			Participation of designer in monthly SCM	10		
ESHS hand book issued to all personnel	10			Detailed supplementary information about ESHS risk of the design given by designer.	10		
Sub total	**50**			**Sub total**	**50**		
1.6 ESHS submittals to Employer	**A**	**B**	**C**	**1.6a ESHS submittals to Employer**	**A**	**B**	**C**
Daily reporting of workmen	10			External ESHS audit report	10		
Monthly ESHS report	10			Electrical safety audit report	10		
ESHS committee meeting minutes	10			Air monitoring report	10		
ESHS inspection report	10			Noise monitoring report	10		
Monthly internal ESHS audit score report	10			Accident, Incident and dangerous occurrence reporting	10		
Sub total	**50**			**Sub total**	**50**		
1.7 Visitors to site	**A**	**B**	**C**		**A**	**B**	**C**
Visitor got the permission from Employer	10						
Contractor have visitor PPEs	10						
Responsible accompanied with visitor	10						
Does visitor entering hazardous area	10						
Visitor register maintain at site office	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

2.0 ESHS Training and ESHS Communication

2.1 Training Policy	A	B	C	2.2 Induction Training	A	B	C
Is training policy in ESHS Plan	10			Does training take place in first week	10		
Is policy implemented	10			Induction Handout	10		
Does it includes sub contractors	10			Project related syllabus	10		
Is training policy published	10			Management participation	10		
Does PM understand training policy	10			Attendance records kept	10		
Sub total	50			Sub total	50		
2.3 Toolbox Talks	**A**	**B**	**C**	**2.4 Supervisor Training**	**A**	**B**	**C**
Are they held at least weekly	10			Is there a recognized programme	10		
Presented by supervisor/safety officer	10			Project related	10		
System monitored by management	10			Senior management participation	10		
Employee involvement	10			Achievement test	10		
Attendance records kept	10			Attendance records kept	10		
Sub total	50			Sub total	50		
2.5 Follow up training	**A**	**B**	**C**	**2.6 Driver/Plant Operator Training**	**A**	**B**	**C**
Is follow up training organized	10			Does Driver/PO training take place	10		
Does it take place after six months	10			Are all drivers undergone for defensive training at IDTR.	10		
Is syllabus project related	10			Are all Drivers and Operators certificated	10		
Attendance records kept	10			Are records kept	10		
Workers participation towards training	10			Are all Drivers Operators retained	10		
Sub total	50			Sub total	50		
2.7 Promotional activities	**A**	**B**	**C**	**2.8 ESHS posters**	**A**	**B**	**C**
Is there a safety promotional programme	10			Are posters adequate no's	10		
Are any incentive schemes used	10			Are posters separately numbered	10		
Are subcontractors included in promotion	10			Are posters cover all topics	10		
Had any worker rewarded so far.	10			Are safety posters visible on site	10		
Management's participation towards this	10			Are posters maintaining regularly	10		
Sub total	50			Sub total	50		
2.9 ESHS Signage	**A**	**B**	**C**	**2.10 Important days to be observed**	**A**	**B**	**C**
Is signage in correct colours	10						
Adequate number of signs	10						
Suitable positioning of signs	10						
Signs in Hindi and English	10						
Are signage maintaining regularly	10						
Sub total	50			Sub total			
Contractor's Observations:				Employer's Observations:			
Section Scores	450			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

3.0 ESHS Inspection and Audit

3.1 Planned General Inspection	**A**	**B**	**C**	**3.2 Routine Inspection**	**A**	**B**	**C**
Monthly contractor and subcontractors' site ESHS committee Inspection	10			Operator Daily Inspection of plant and equipment	10		
Weekly ESHS inspection by supervisors	10			Monthly Inspection of electrical hand tools	10		
Daily ESHS inspection by site ESHS team	10			Quarterly Inspection of temporary electrical systems	10		
Employer's and contractor's representative involved in this ESHS inspection	10			Weekly Inspection of scaffold by scaffolding supervisor	10		
Records maintenance	10			Half-yearly inspection of lifting appliances and gears by competent person	10		
Sub total	**50**			**Sub total**	**50**		
3.3 Specific Inspection	**A**	**B**	**C**	**3.4 ESHS Inspection**	**A**	**B**	**C**
Before a heavy lifting operation	10			Is Contractor prepare checklist for all activity	10		
Before & after entry into confined space	10			Checklist mentioned in contractor ESHS plan	10		
Before & after a welding & gas cutting	10			All inspection reports registered	10		
Before concreting formwork	10			Inspection reports sent to Employer	10		
All high-risk processes inspected by competent supervisor	10			Planned and Routine Inspection used for discussion in ESHS Committee Meeting	10		
Sub total	**50**			**Sub total**	**50**		
3.5 MARS	**A**	**B**	**C**	**3.6 Electrical safety audit**	**A**	**B**	**C**
Performed once in a month	10			Covered all areas	10		
Project Manager accompanied this audit	10			Performed once in a month	10		
Conducted at least 7 days prior to Monthly ESHS Committee meeting	10			Team comprising of senior ESHS (Elect) engineer	10		
Audit Report will be sent to Employer	10			Audit Report will be sent to Employer	10		
Corrective actions taken	10			Corrective actions taken	10		
Sub total	**50**			**Sub total**	**50**		
3.7 External Audit (General)	**A**	**B**	**C**	**3.8 External Audit**	**A**	**B**	**C**
Conducted by external agencies	10			Contents and coverage	10		
Auditors ISO qualified and competent	10			Available documents	10		
Approval of the Employer	10			Qualification of audit team members	10		
Audit report as per ISO/ILO standard	10			Had checklist prepared	10		
Conducted on a quarterly basis	10			Status of NCR of external audit	10		
Sub total	**50**			**Sub total**	**50**		
3.9 Audit Report	**A**	**B**	**C**		**A**	**B**	**C**
Audit report as per ISO/ILO standard	10						
Audit conformity / non-conformity report to the Employer	10						
Report contents and coverage	10						
Corrective action by contractors	10						
Initial audit for checking the adequacy of implementation	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
4.0 Hazard Identification, Risk Assessment and Emergency Preparedness							
4.1 Policy for Identifying Hazards	**A**	**B**	**C**	**4.2 Risk Assessment**	**A**	**B**	**C**
Procedure for identifying hazards	10			Are risk assessment carried out	10		
Is there a list of significant hazards	10			Is there a formal process	10		
Procedure for Risk Assessment	10			Are worksheets used	10		
Whether any schedule or hierarchy made	10			Are records kept in site office	10		
Ranking of hazards	10			Whether control measures are planned	10		
Sub total	**50**			**Sub total**	**50**		
4.3 Method Statements	**A**	**B**	**C**	**4.4 Permit to work in use**	**A**	**B**	**C**
Are Method Statements produced	10			Is there a procedure for Permits to work	10		
Dot hey contain clear instruction	10			Issued by Authorized person	10		
Are they given to work supervisors	10			Issued for defined period	10		
Is correct information given to workers	10			Workers instructed	10		
Step by step description of task	10			Are records kept of Permits issue	10		
Sub total	**50**			**Sub total**	**50**		
4.5 Emergency Preparedness Plan	**A**	**B**	**C**	**4.6 Emergency control centre**	**A**	**B**	**C**
Is there description within Safety Plan	10			Available of first-aid box	10		
Is it up to date	10			Public addressing system	10		
Is it well published	10			Emergency phone numbers	10		
Does Project Manager have copy	10			Emergency alarm	10		
Exercise within past three months	10			Employees name list	10		
Sub total	**50**			**Sub total**	**50**		
4.7 Communication system	**A**	**B**	**C**	**4.8 Plan Details**	**A**	**B**	**C**
Public addressing system	10			Details of emergency co-ordinator	10		
Emergency power supply	10			Designated personnel with Tel. Nos.	10		
Mobile phone in Emergency care centre	10			Are telephone numbers up to date	10		
Warning boards	10			Emergency response team identified	10		
Records maintained for usage and maintenance of communication systems	10			Functions of Team identified	10		
	50			**Sub total**	**50**		
4.9 Requirements	**A**	**B**	**C**	**4.10 First Aid**	**A**	**B**	**C**
Link to Police	10			Is First Aid included in Safety Plan	10		
Link to Fire Services	10			Are adequate no. of First aiders appointed	10		
Link to Ambulance and Hospital	10			Record keep of qualification	10		
Communication to employees	10			First aid boxes supplied	10		
Displayed on Notice Boards	10			First aid boxes properly equipped	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	500			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

5.0 Reporting of Accidents and Dangerous Occurrences and Accident Investigations

5.1 Reporting to Employer	A	B	C	5.2 Reporting to Govt. organisation	A	B	C
Verbal information	10			Reporting to Regional Labour Commissioner	10		
Written information within 24 hrs	10			Reporting to welfare board	10		
Delay in reporting	10			Reporting to director general	10		
Are all accidents identified and recorded	10			Reporting to police station	10		
Are AFR rates calculated	10			Reporting to District Magistrate	10		
Sub total	50			Sub total	50		
5.3 Incident Reporting	**A**	**B**	**C**	**5.4 Follow up Action**	**A**	**B**	**C**
Is there a proper reporting procedure	10			Does Senior Manger review all reports	10		
Is the procedure communicated to all	10			Is result of investigation published	10		
Are reports available for inspection	10			Are workers advised of remedial action	10		
Do reports accurately describe incident	10			Are failure in Management recognized	10		
Is standardised form used	10			Whether statistics report prepared	10		
Sub total	50			Sub total	50		
5.5 Procedure for investigation	**A**	**B**	**C**	**5.6 Incident Investigation**	**A**	**B**	**C**
Made Photographs and sketches	10			Are witness statement taken	10		
Examine involved equipment	10			Is the chain of events identified	10		
Interviewed the eye-witnesses	10			Is specific sub contractor identified	10		
Consulted expert opinion	10			Investigation kit available	10		
Environmental conditions	10			Investigation report made available to Employer	10		
Sub total	50			Sub total	50		
	A	**B**	**C**		**A**	**B**	**C**
Sub total				Sub total			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	300			Section % Score	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
6.0 Housekeeping							
6.1 Procedure	A	B	C	**6.2 Organisation**	A	B	C
Is it mentioned in ESHS plan	10			Adequacy of housekeeping personnel	10		
Responsibility classified	10			Is housekeeping personnel trained	10		
Housekeeping round the clock	10			Employer's approval for housekeeping personnel	10		
Reporting of housekeeping personals to ESHS Manager	10			Intimation of vacancy to Employer	10		
Housekeeping persons provided no. / badge	10			Persons provided with suitable logistics / aid	10		
Sub total	50			**Sub total**	50		
6.3 Housekeeping squad	A	B	C	**6.4 Barricades**	A	B	C
Housekeeping plan	10			Dimension of the board	10		
Member list	10			HRIDC logo	10		
Job allocation and time allocation	10			Sequential Numbering	10		
Periodicity of housekeeping	10			Availability of protruding parts	10		
Documentation of housekeeping	10			Regular cleaning and painting	10		
Sub total	50			**Sub total**	50		
6.5 Access / Egress way	A	B	C	**6.6 Dustbins**	A	B	C
Free from debris	10			Lumbar with protruding nails	10		
Unprotected opening	10			Unprotected projection	10		
Free from obstructions	10			Scattered unused materials	10		
Slippery condition	10			Spill of bentonite	10		
Spillage of water or oil	10			Fencing and guarding of equipments	10		
Sub total	50			**Sub total**	50		
6.7 Housekeeping at worksites	A	B	C	**6.8 Housekeeping at roads**	A	B	C
Lumbar with protruding nails	10			Tyre cleaning of vehicles	10		
Unprotected projection	10			Parking of construction vehicles at road	10		
Scattered unused materials	10			Water logging or bentonite spill on road	10		
Fencing and guarding of equipments	10			Roads kept clean	10		
Stacking and storing of materials	10			Position of barricades lying at roads	10		
Sub total	50			**Sub total**	50		
6.9 Storage of cylinders	A	B	C		A	B	C
Full / empty separated	10						
Gases separated	10						
Protected from weather	10						
Contents labelled	10						
MSDS available for each gas	10						
Sub total	50			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	450			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:						
7.0 Working at Height							
7.1 Organisation and planning	**A**	**B**	**C**	**7.2 Fragile surface**	**A**	**B**	**C**
Adequate number of trained personnel	10			Suitable working platform	10		
Supervision	10			Guard rails	10		
Planning emergency and rescue	10			Crawling boards	10		
Work permit system	10			Warning notice	10		
Refresher training	10			Work permit system to work	10		
Sub total	**50**			**Sub total**	**50**		
7.3a Scaffolding	**A**	**B**	**C**	**7.3b Scaffolding**	**A**	**B**	**C**
Is scaffolding included in ESHS Plan	10			Scaffolds constructed for correct use	10		
Are scaffolding erected and dismantled by competent workmen	10			Are scaffolds constructed of sound material without patent defect	10		
Are records kept of inspections	10			No unsuitable material	10		
Security fixed or buttressed	10			Working platforms fully boarded	10		
Working platforms free from rubbish	10			Guardrails and mid rails fitted	10		
Sub total	**50**			**Sub total**	**50**		
7.3c Scaffolding	**A**	**B**	**C**	**7.4a Ladders**	**A**	**B**	**C**
Secure ladder access provided	10			Are ladders specified in Safety Plan	10		
Toe board provided	10			Is there a system for checking ladders	10		
'Safe for Use' board erected	10			Are records kept of weekly checks	10		
Availability of base plate	10			Using of Bamboo ladders	10		
Free from rust / corrosion / debris	10			Painting of ladders	10		
Sub total	**50**			**Sub total**	**50**		
7.4b Ladders	**A**	**B**	**C**	**7.5 Guardrails**	**A**	**B**	**C**
Safety procedure followed	10			Present at all working platforms	10		
Rubber bush in aluminium ladder	10			Securely attached	10		
Landing properly	10			Sound material	10		
Climbing procedure	10			Designed as per standard	10		
Rungs at proper intervals	10			Maintained properly	10		
Sub total	**50**			**Sub total**	**50**		
7.6 Harnesses	**A**	**B**	**C**	**7.7 Safety net**	**A**	**B**	**C**
Is use of harnesses specified in ESHS Plan	10			Approved type	10		
Are harnesses of full body type	10			Good construction	10		
Are secure anchorage points used	10			Adequate number to issue	10		
Has instruction on correct use been given	10			Testing	10		
Maintenance and inspection	10			Maintenance	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	500			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:				Contractor's Name:			
8.0 Lifting Operations and Gears							
8.1 Certification	A	B	C	**8.2 ASLI / Other Indicators**	A	B	C
Procedure is available in ESHS Plan	10			Free from damage	10		
Fitness / Test Certificates available	10			In operable conditions	10		
Daily inspection records maintained	10			Overload device tested	10		
Load chart for lifting appliances	10			Overload device operable	10		
Employer's approval for lifting appliances	10			Bypass key made available to I/C	10		
Sub total	50			Sub total	50		
8.3 Wire Ropes	A	B	C	**8.4 Safety Hooks**	A	B	C
Free from damage	10			Free from damage	10		
Lubricated	10			Safety latch fitted	10		
Correctly anchored	10			Safety latch in operable condition	10		
Splicing method	10			Other form of hook closure	10		
Inspection & Testing	10			Test certificates	10		
Sub total	50			Sub total	50		
8.5 Slings, Chains & Shackles	A	B	C	**8.6 Outriggers (Mobile Cranes)**	A	B	C
Properly stored when not in use	10			Outriggers locked in position	10		
In good condition without defects	10			Jacks in good condition	10		
Market with safe working load	10			Jacks firmly supported	10		
Bulldog clips correct fit/number	10			Wheels clear/not supporting load	10		
Correctly used	10			Chassis level	10		
Sub total	50			Sub total	50		
8.7 Operator and Operator cabin	A	B	C	**8.8 Rigging requirement**	A	B	C
Licence for HMV	10			Rigger qualification & experience	10		
Competent & skilled	10			Load assessment	10		
Medical fitness certificate	10			Type of slings to be used	10		
Portable fire extinguisher	10			Hooks & lifting assessment	10		
Defensive driving at IDTR	10			Overhead power line	10		
Sub total	50			Sub total	50		
8.9 Alarms & signals	A	B	C	**8.10 Accessories & controls**	A	B	C
Overload alarm	10			Side & rear view mirror	10		
Over hoist alarm	10			Clutch & brake	10		
Reverse horn	10			Swing & Extension control	10		
Pressure indicators	10			Illumination	10		
Outrigger extension alarm	10			Maintenance	10		
Sub total	50			Sub total	50		
Contractor's Observations				**Employer's Observations:**			
Section Scores	500			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:				**Contractor's Name:**			
9.0 Construction Machinery / Hand tools and power tools							
9.1 Machinery Fencing	**A**	**B**	**C**	**9.2 Maintenance**	**A**	**B**	**C**
All moving parts effectively guarded	10			All maintenance properly maintained	10		
Fencing not removed	10			No maintenance whilst M/c in motion	10		
Is procedure in ESHS Plan	10			Records of maintenance kept	10		
Warning board	10			Work Permit System	10		
Emergency stop switch	10			Use of 'Lock Out and Tag Out' (LOTO)	10		
Sub total	**50**			**Sub total**	**50**		
9.3 Air Receivers	**A**	**B**	**C**	**9.4 Wood working machines**	**A**	**B**	**C**
Fitted with pressure relief valve	10			Top guard fitted	10		
Annual test carried out	10			Working space	10		
All couplers with safety chains/wired	10			Guards to protect all drive belts	10		
Condition of hoses	10			Emergency stop switch	10		
Noise level under permissible limit	10			Push stick used	10		
Sub total	**50**			**Sub total**	**50**		
9.5 Grinding machine	**A**	**B**	**C**	**9.6 General**	**A**	**B**	**C**
Appropriate guards fitted	10			Is procedure in ESHS plan	10		
Correct size wheel/disc fitted	10			All operator medically fir and above 21 yrs	10		
Spindle speed marked on M/s	10			Unauthorized riding on plant	10		
Name plate for equipment specification	10			Inspection and maintenance record	10		
Test and maintenance	10			Portable fire extinguisher	10		
Sub total	**50**			**Sub total**	**50**		
9.7 Safe Operating Procedure	**A**	**B**	**C**	**9.8 Requirements**	**A**	**B**	**C**
Available for all machines	10			Manufacturer specification	10		
Available in the working area	10			Control switch	10		
Operator trained	10			GFCI / RCCB and other safety devices	10		
Operator know the same	10			IP 44 plugs, sockets & connectors	10		
Updated regularly	10			Guarding	10		
Sub total	**50**			**Sub total**	**50**		
9.9 Maintenance and Inspection	**A**	**B**	**C**	**9.10 PPE**	**A**	**B**	**C**
Daily inspection	10			Ear protection	10		
Lubrication	10			Hand Protection	10		
Pneumatic and hydraulic pressure	10			Eye protection	10		
Record maintenance	10			Apron	10		
Label displayed in the equipment itself.	10			Nose / face mask	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

10.0 Site Electricity

10.1 Power assessment	A	B	C	10.2 Distribution Panels	A	B	C
Load calculation for power requirement	10			Panel secure box to IP 44	10		
Employer's approval for execution of the job	10			All cables enter box through glands	10		
Is small capacity diesel generator present	10			ELCB or RCCB/ GFCI fitted	10		
Noise from diesel generator	10			Proper earth connection and earth pit	10		
Sub-contractor's power requirement by main contractor	10			Warning signs in appropriate position	10		
Sub total	**50**			**Sub total**	**50**		
10.3 Cables	**A**	**B**	**C**	**10.4 Work on site**	**A**	**B**	**C**
All cables free from damage	10			Site electricity covered in the ESHS Plan	10		
Cables lying on the ground / water	10			Name posted on Main Distribution Board	10		
Cable joints made by IP 44 connectors	10			Single line & Schematic diagram submitted	10		
Correct storage when not in use	10			Employer's Approval for execution	10		
Colour coding	10			GFCI provided	10		
Sub total	**50**			**Sub total**	**50**		
10.5 Electrical professional	**A**	**B**	**C**	**10.6 Earth Pit**	**A**	**B**	**C**
Sufficient numbers	10			As per standard	10		
Professionally qualified	10			Wet condition	10		
Roles and responsibilities defined	10			Pouring 5 litre water per days	10		
Valid license to electrical persons	10			Earth pipe free from corrosion	10		
Training	10			Earth resistance	10		
Sub total	**50**			**Sub total**	**50**		
10.7 Plugs, Sockets and outlets	**A**	**B**	**C**	**10.8 Voltage / Current**	**A**	**B**	**C**
Are all plugs, sockets and outlets IP 44 type	10			Check voltage / current limit	10		
Colour coding of plugs and sockets	10			Rating clearly marked on all equipments	10		
All cables fitted with IP 44 Plugs	10			Monitored continuously	10		
All equipments connected with plugs	10			Mismatch of cable and equipments ratings	10		
All equipments free from defects	10			Properly earthed	10		
Sub total	**50**			**Sub total**	**50**		
10.9 Maintenance	**A**	**B**	**C**	**10.10 Correct Disc. / Revolutions**	**A**	**B**	**C**
Regular inspections carried out	10			Information plate on tool	10		
Records kept	10			Information on Disc/Cutter	10		
Suitable guards/security fenced	10			Compatibility between Tool and Disc	10		
Faults actioned	10			Operator trained/competent to fit Disc	10		
Record maintaining	10			Safety check on condition	10		
Sub total	**50**			**Sub total**	**50**		

Contractor's Observations:	Employer's Observations:

Section Scores	500			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:				Contractor's Name:			
11.0 Fire prevention							
11.1 Fire fighting personnel	**A**	**B**	**C**	**11.2 Requirements**	**A**	**B**	**C**
Adequacy of Fire fighting personnel	10			Emergency plan	10		
Professionally qualified	10			Fire excavation plan	10		
Employer's approval	10			Mock drill	10		
Intimation of vacancy to Employer	10			Nearest fire brigade phone numbers	10		
Adequate no of trained persons	10			Reporting of fire accident to Employer	10		
Sub total	50			**Sub total**	50		
11.3 Combustible material	**A**	**B**	**C**	**11.4 Fire Extinguisher**	**A**	**B**	**C**
Used in site	10			Adequate numbers	10		
Handling of combustible material	10			Appropriate type	10		
Stored in separate place	10			Easily accessible	10		
Spillage of materials	10			Frequency of recharge	10		
Location of burning site	10			Maintenance and inspection	10		
Sub total	50			**Sub total**	50		
11.5 Fir fighting equipments	**A**	**B**	**C**		**A**	**B**	**C**
Sufficient quantity of water supply	10						
Fire hose and nozzle	10						
Fire alarm	10						
Condition of fire hydrants	10						
Sufficient no. available	10						
Sub total	50						
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	250			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.: | Contractor's Name:

12.0 Welding & Cutting

12.1 Gas Welding / Cutting	**A**	**B**	**C**	**12.2 storage of cylinders**	**A**	**B**	**C**
Is procedure in ESHS Plan	10			Is procedure in ESHS Plan	10		
Are cylinders in cylinder-trolley	10			Storage in upright position	10		
Are pressure gauges fitted and operable	10			Full/empty segregated	10		
Are flashback arresters fitted	10			Different gases separated	10		
Are non return valves fitted	10			Contents labelled	10		
Sub total	**50**			**Sub total**	**50**		
12.3 Condition of cylinders	**A**	**B**	**C**	**12.4 Hose**	**A**	**B**	**C**
No damage by misuse	10			Colour coding	10		
No rust/corrosion	10			Hose clip and clamp	10		
Protected from weather	10			Is it free from leak and damage	10		
Colour coding proper	10			Hose lying on the ground	10		
MSDS available	10			Joints if any	10		
Sub total	**50**			**Sub total**	**50**		
12.5 Electric Arc Welding	**A**	**B**	**C**	**12.6 Transformer**	**A**	**B**	**C**
Are welding machines in good order	10			Presence of voltmeter and ammeter	10		
Welding leads free form defect	10			Separate main power switch	10		
Welding return free from defect	10			Ground connection	10		
Electrode holder properly insulated	10			Specification plate or board	10		
Dipping electrode in water when it is hot	10			Protected from weather	10		
Sub total	**50**			**Sub total**	**50**		
12.7 Electrical Cable	**A**	**B**	**C**	**12.8 Work Area**	**A**	**B**	**C**
Cable lying on ground / water	10			Area clear of flammable substances	10		
IP 44 cable connectors instead of insulation tape	10			Smoking inside the work area	10		
Damaged and exposed wires	10			Fire extinguisher fitted	10		
Separate earthing connection from work piece to transformer	10			Welding screens available	10		
Electrical protection devices ELCB, RCCB,etc	10			Ventilation and fume extraction	10		
Sub total	**50**				**50**		
12.9 PPE for welder, cutter and helper	**A**	**B**	**C**		**A**	**B**	**C**
Face and eye protection	10						
Gauntlet gloves	10						
Safety footwear	10						
Nose mask	10						
Ear muff / plug	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	450			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:				Contractor's Name:			
13.0 Excavations and Trenching							
13.1 Planning	**A**	**B**	**C**	**13.2 Access/Egress**	**A**	**B**	**C**
Are excavations covered in ESHS Plan	10			Suitable ladders provided	10		
Examined by competent person	10			Ladders properly secured	10		
Records of inspection maintained	10			Alternative ladders available	10		
Underground cable and pipelines	10			Staircase for excavation more 1.5 m depth	10		
Backfilling and removal of trench	10			Guardrail for staircase.	10		
Sub total	**50**			**Sub total**	**50**		
13.3 Shoring	**A**	**B**	**C**	**13.4 Barriers and Warnings**	**A**	**B**	**C**
Shoring as soon as earth is removed	10			Rigid barrier around excavation	10		
Suitable support	10			Suitable warning notices	10		
Regular monitoring	10			Regularly checked by supervisor	10		
Proper repair under taken	10			Warning light & signs	10		
Material stacked properly on removal	10			Emergency exit board	10		
Sub total	**50**			**Sub total**	**50**		
13.5 Soil	**A**	**B**	**C**	**13.6 Underground Services**	**A**	**B**	**C**
Not closer than 1 metre	10			Checks made with Utility providers	10		
Properly stacked	10			Safe digging procedures in use	10		
Excavator clear of personnel	10			Supervision has service plans	10		
Storage of Excavated materials	10			Dewatering procedures	10		
Logistics for excavated soil	10			Line of dewatering	10		
Sub total	**50**			**Sub total**	**50**		
13.7 Undermining Nearby Structures	**A**	**B**	**C**	**13.8 Portable Electrical Equipment**	**A**	**B**	**C**
Survey carried out	10			Are as per standard	10		
Temporary support provided if required	10			Proper repair and condition	10		
Vibration measured	10			Rating voltage more than 24 V	10		
Regular monitoring	10			Double insulation	10		
Sufficient clearance provided	10			Open bare wires	10		
Sub total	**50**			**Sub total**	**50**		
13.9 Ventilation and Illumination	**A**	**B**	**C**	**13.10 Signals & Communication**	**A**	**B**	**C**
Are as per standard	10			Audio, Video signals	10		
Exhaust fan arrangement	10			Walkie-talkie / radio /mobile phones	10		
Temperature management	10			Head protection	10		
Gas monitoring systems	10			Arm protection	10		
Lighting arrangement	10			Leg protection	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
14.0 Tunnelling and Confined Space operations							
14.1 Procedure	**A**	**B**	**C**	**14.2 Equipments**	**A**	**B**	**C**
Procedure in ESHS Plan	10			Gas monitoring equipment	10		
Permit Work system in use	10			Rescue BA equipment	10		
Only properly trained operatives	10			Full body harness for each worker	10		
Existing underground cables and pipelines	10			Tripod and lifeline	10		
Refresher training	10			Resuscitation Equipment	10		
Sub total	50			**Sub total**	50		
14.3 Access and Egress	**A**	**B**	**C**	**14.4 Procedure**	**A**	**B**	**C**
Proper staircase and lift	10			Inform to Director General before 30 days	10		
Guardrail for staircase	10			Emergency power generator	10		
Staircase made of sound material	10			Watertight bulkhead doors at entrance	10		
Free from defects	10			Reflective jackets for workers	10		
Emergency exit	10			Dewatering procedures	10		
Sub total	50			**Sub total**	50		
14.5 Warning / Communication systems	**A**	**B**	**C**	**14.6 Electrical equipment**	**A**	**B**	**C**
Telephone / walkie-talkie	10			Flame proof electrical equipment	10		
Emergency Alarm	10			Portable tools more than 24 V	10		
Warning for Exit way and electrical panel boards	10			Double insulation / earthing condition of portable equipment	10		
High visibility waist	10			Transformer used in without compressed air	10		
Warning lights	10			Bare conductor or semi enclosed fuse	10		
Sub total	50			**Sub total**	50		
14.7 Illumination and Ventilation	**A**	**B**	**C**	**14.8 Compressed air**	**A**	**B**	**C**
Illumination / ventilation levels	10			Adequacy of air supply	10		
Air circulation	10			Emergency power supply	10		
Level of oxygen / other toxic gas	10			Flame proof equipment	10		
Temperature level (not more than 29° C)	10			Available in man-locks and medical-locks	10		
Emergency power supply for luminaries	10			Hoses free from damage	10		
Sub total	50			**Sub total**	50		
14.9 Fire Prevention	**A**	**B**	**C**	**14.10 Health and Welfare**	**A**	**B**	**C**
Adequate water supply	10			Man-lock and medical-lock	10		
Fire alarm	10			Drinking water	10		
Flammable materials inside work areas	10			Medical officer	10		
Water outlet points	10			First-aid room	10		
Inspection and maintenance	10			Shelter room	10		
Sub total	50			**Sub total**	50		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	500			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:				**Contractor's Name:**			
15.0 Traffic management							
15.1 Traffic marshals	**A**	**B**	**C**	**15.2 Vehicle operators**	**A**	**B**	**C**
Sufficient numbers	10			Driving licence	10		
Professionally qualified or trained	10			Medically fitness	10		
Medically fit	10			Defensive driving training	10		
Driving licence	10			Refresher training	10		
Familiar with traffic signs	10			Fire fighting training	10		
Sub total	**50**			**Sub total**	**50**		
15.3 Traffic control devices	**A**	**B**	**C**	**15.4 Barricades**	**A**	**B**	**C**
Cons	10			Erected around the construction site	10		
Drums	10			Free from defects and protruding parts	10		
Delineators	10			Numbered	10		
Traffic cylinders	10			Painted and maintained in good condition	10		
Traffic signs and barricades	10			Barricade register	10		
Sub total	**50**			**Sub total**	**50**		
15.5 Barricades	**A**	**B**	**C**	**15.6 Regulatory Signs**	**A**	**B**	**C**
Barricade inspector & supervisor appointed	10			Approval from police and traffic authorities	10		
Retro reflective strips shape and size	10			Warning signs	10		
Reflective strips placed at a angle at bottom	10			Red light / flag indicator	10		
Minimum gap between retro reflective strips 1000mm	10			Design as per employer's approval	10		
One red light / blinker per barricade	10			Material made of reflective type.	10		
Sub total	**50**			**Sub total**	**50**		
15.7a Vehicle	**A**	**B**	**C**	**15.7b Vehicle**	**A**	**B**	**C**
Vehicle number and company name	10			Brakes in good working order	10		
Inspection stickers & license plate	10			Are wiper blades in good condition	10		
Seat belts	10			Rear view mirrors	10		
Two reflective triangles on rear side	10			Speedometer	10		
Fog lights (front & rear)	10			Vehicle's horn and reverse alarm	10		
Sub total	**50**			**Sub total**	**50**		
15.8 Heavy motor vehicles	**A**	**B**	**C**	**15.9 Operator cabin**	**A**	**B**	**C**
Automatic safe load indicator	10			Made of fire resistance material	10		
Load chart of the vehicle	10			Protection from vibration	10		
Fitness certificate	10			Weather protection	10		
Manufacturer details	10			Adequate ventilation	10		
Marking of safe working load	10			Suitable fire extinguisher	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	500			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

16.0 Personal Protective Equipment

16.1 Head Protection	A	B	C	16.2 Foot Protection	A	B	C
Use enforced	10			Use enforced	10		
As per standard	10			Suitable type	10		
In good condition	10			Toecaps effective	10		
Colour and company logo	10			Fair condition	10		
Available for issue	10			Available for issue	10		
Sub total	50			Sub total	50		
16.3 Eye protection	**A**	**B**	**C**	**16.4 Hearing Protection**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
Suitable type	10			Suitable type	10		
Good condition	10			Available for issue	10		
Available for issue	10			Noise levels monitored	10		
Sub total	50			Sub total	50		
16.5 Respiratory Protection	**A**	**B**	**C**	**16.6 Protective Gloves**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
Suitable type	10			Correct type for operation	10		
Good condition	10			Good condition	10		
Available for issue	10			Available for issue	10		
Sub total	50			Sub total	50		
16.7 High-Visible Waist	**A**	**B**	**C**	**16.8 Fall Protection**	**A**	**B**	**C**
Use enforced	10			Use enforced	10		
As per standard	10			As per standard	10		
In good condition	10			In good condition	10		
Warning signs displayed	10			Warning signs displayed	10		
Available for issue	10			Available for issue	10		
Sub total	50			Sub total	50		
16.9 PPE for visitors	**A**	**B**	**C**		**A**	**B**	**C**
Use enforced	10						
10% PPEs for visitors in site office	10						
In good condition	10						
Colour and company logo	10						
Available for issue	10						
Sub total	50			Sub total			
Contractor's Observations:				Employer's Observations:			
Section Scores	450			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:				Contractor's Name:			
17.0 Industrial Health & Hygiene and Lighting & Ventilation							
17.1 Medical examination	**A**	**B**	**C**	**17.2 Occupational Health Centre**	**A**	**B**	**C**
All worker under gone	10			Construction medical officer & qualification	10		
Covered all testes as per standard	10			Availability nurse & sweeper	10		
Conducted by qualified person	10			Floor area minimum 15 m^2 with two rooms	10		
Confidential report for all workers	10			Adequate equipment	10		
Frequency of medical test maintained	10			Medical emergency equipments	10		
Sub total	**50**			**Sub total**	**50**		
17.3 First-aid	**A**	**B**	**C**	**17.4 Ambulance van and room**	**A**	**B**	**C**
Equipped with all items as per standard	10			Equipped with all items as per standard	10		
Sufficient numbers	10			Availability and numbers	10		
First-aid room facility	10			Maintained in good repair	10		
First-aider & his qualification	10			Equipped with standard facilities	10		
Register for first-aid	10			Record of all cases of accident & sickness	10		
Sub total	**50**			**Sub total**	**50**		
17.5 Mosquito breeding	**A**	**B**	**C**	**17.6 Alcohol and drugs & HIV / AIDS prevention**	**A**	**B**	**C**
Water retain on the site	10			Employee working under the influence of alcohol / drugs	10		
Periodic interval	10			Smoking at public worksites	10		
Still waters	10			Smoking at public worksites	10		
Posters	10			HIV / AIDS awareness training provided	10		
Usage of insecticides	10			Workers participation / co-operation	10		
Sub total	**50**			**Sub total**	**50**		
17.7 Noises	**A**	**B**	**C**	**17.8 Vibration**	**A**	**B**	**C**
Are procedures for noise evaluation in the Safety Plan	10			Monitoring method	10		
Are noise assessments carried out	10			Frequency of monitoring	10		
Are noise zones identified	10			Vibration limits	10		
Is correct PPE provided	10			Report maintenance	10		
Usage of PPE	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
17.9 Radiation	**A**	**B**	**C**		**A**	**B**	**C**
Method statement	10						
Approval from Employer	10						
Use and storage of radioactive substance	10						
Disposal of radioactive substance	10						
Appropriate PPE	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

18.0 Welfare amenities

18.1 Toilets / Urinals	A	B	C	18.1a Toilets / Urinals	A	B	C
Enough no available	10			Is it properly illuminated	10		
Separate for men and women	10			Is it having separate and ample water facility	10		
Access within 500m from worksite	10			Is it having proper drainage system	10		
Is it properly cleaned	10			Water leaking or spillage	10		
Is it washed regularly	10			Records kept and available	10		
Sub total	50			**Sub total**	50		
18.2 Drinking water	**A**	**B**	**C**	**18.3 Canteen**	**A**	**B**	**C**
Quantity is sufficient	10			Is canteen available	10		
Quality is good	10			Is it neat and clean	10		
Laboratory test done	10			Is the flooring dust free	10		
Access within 200m from worksite	10			Is the cost 'no loss and no gain' basis	10		
Is it 6m away from toilets and urinals	10			Lighting, ventilation and water facility	10		
Sub total	50			**Sub total**	50		
18.4 Labour Accommodation	**A**	**B**	**C**	**18.5 Creaches**	**A**	**B**	**C**
Cooking, bathing, washing and lavatory facilities	10			Is it free from mosquito and other biological agent	10		
Is it free from mosquito and biological agent	10			In-charge to keep the children.	10		
Is it properly illuminated and ventilated	10			Is it properly illuminated and ventilated	10		
Is it adequate for all	10			Is it adequate for all	10		
Is it neat, clean and hygiene	10			Is it neat, clean and hygiene	10		
Sub total	50			**Sub total**	50		
18.6 Shelter	**A**	**B**	**C**	**18.7 Illumination**	**A**	**B**	**C**
Adequate to all workers	10			Minimum illumination requirement	10		
Is it properly illuminated and ventilated	10			Minimum 50 lux at work place	10		
Is it neat, clean and hygiene	10			Minimum 30 lux on trolley tracks	10		
Is it free from mosquito and biological agent	10			Minimum 10 lux elsewhere	10		
Drinking water and Toilet facilities	10			Adequate Emergency lighting provided	10		
Sub total	50			**Sub total**	50		
18.8 Ventilation	**A**	**B**	**C**		**A**	**B**	**C**
Oxygen level less than 19.5	10						
Air circulation of 6m^3/min for each building Worker employed underground	10						
Free air flow movement in work place	10						
Ventilation system in operation	10						
Maintenance records kept and available	10						
Sub total	50			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	450			**Section % Score**	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:				Contractor's Name:			
19.0 Environmental management							
19.1 Air quality	**A**	**B**	**C**	**19.2 Water quality**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
19.3 Noise monitoring	**A**	**B**	**C**	**19.4 Illumination monitoring**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	**50**			**Sub total**	**50**		
19.5 Temperature monitoring	**A**	**B**	**C**	**19.6 Dust control**	**A**	**B**	**C**
Monitoring by competent person	10			Water sprinkler arrangement	10		
Monitoring equipment as per standard	10			Frequency water sprinkler inside the site	10		
Monitoring method	10			Dust screens	10		
Report to Employer	10			Dust level under permissible limit	10		
Control plan	10			Environmental monitoring	10		
Sub total	**50**			**Sub total**	**50**		
19.7 Waste Management	**A**	**B**	**C**	**19.8 Felling of Trees**	**A**	**B**	**C**
Dustbin in construction site	10			Approval from forest department	10		
Temporary dumping area	10			Trees used for anchorage.	10		
Separate dumping pit for disposable and non-disposable wastes	10			Trees exposed or injured by construction equipment	10		
Frequency of removal of waste	10			Protective barriers around tree	10		
Burning of waste	10						
Sub total	**50**			**Sub total**	**40**		
19.10 Energy Management	**A**	**B**	**C**		**A**	**B**	**C**
Uniform illumination	10						
Size and length of cable and wires	10						
Efficient luminaries	10						
Efficient motors and pumps	10						
Efficient air-conditions	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**440**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD..

Contract No.:	Contractor's Name:

20.0 Batching Plant and Casting Yard

20.1 General	A	B	C	20.2 Layout	A	B	C
Is procedure in ESHS Plan	10			Plan of layout	10		
All operators medically fit/over 21	10			Drainage system	10		
No unauthorized riding on plant	10			Welfare amenities	10		
Daily inspections / recorded	10			Plan for vehicle moving area	10		
Equipped with all	10			Barrication	10		
Sub total	**50**			**Sub total**	**50**		
20.3 Material Handling & dust protection	**A**	**B**	**C**	**20.4 PPE**	**A**	**B**	**C**
Handling of cement bag	10			Hand protection	10		
Loading and unloading cement	10			Respiratory protection	10		
Handling of launching segments	10			Head protection	10		
Is dust level under permissible limit	10			Foot protection	10		
Environmental monitoring	10			Ear protection	10		
Sub total	**50**			**Sub total**	**50**		
20.5 Traffic management	**A**	**B**	**C**	**20.6 Welfare facilities**	**A**	**B**	**C**
Barricades	10			Toilet	10		
Warning boards	10			Drinking water	10		
Traffic marshals	10			Canteen	10		
Delineators	10			Shelter	10		
Lane warning	10			Labour accommodation	10		
Sub total	**50**			**Sub total**	**50**		
20.7 Fitness certificate	**A**	**B**	**C**		**A**	**B**	**C**
Crane	10						
Hydra and all equipment	10						
Ropes and chains	10						
Hooks and shackles	10						
Rigger & Operator	10						
Sub total	**50**			**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			

Contractor's Observations:	Employer's Observations:

Section Scores	350			Section % Score	100		

General Instruction: ESHS/GI/010

ELECTRICAL SAFETY AUDIT CHECKLIST			
Contract No			
Contractor			
Name of Site			
Audit No			
Audit By		Date	

A. WHETHER DOCUMENTS AVAILABLE FOR THE FOLLOWING

Sr. No	Points	Clause No	Observations	Comments
1	Electrical Safety education & promotion programs		Yes / No	
2	Approval for procurement of new electrical equipment in consultation with Safety dept.		Yes / No	
3	Electrical accident & dangerous occurrences reporting, analysis, investigation, and rating		Yes / No	
4	Inspected list of Electrical duty personal protective equipment (PPE)		Yes / No	
5	Standard operating procedures (SOPs) & standard maintenance procedures (SMPs) for each type of electrical equipment		Yes / No	
6	Electrical isolation system for maintenance of main panels, DBs, SDBs. (LOTO System)		Yes / No	
	Work permit system available for all kind of electrical operations		Yes / No	
7	i) Electrical single line diagram for the electrical installations		Yes / No	
	ii) Schematic diagram for each site with the location of equipment, DBs, SDBs, earth pit, etc.		Yes / No	
	iii) The list and detail of the equipment for all temporary Electrical installation and equipment's		Yes / No	
8	Evaluation of Competency of electrical personnel		Yes / No	

B. ELECTRICAL SAFETY AUDITS, CHECKS, INSPECTIONS, STUDIES & TESTS

Sr. No	Points	Clause No	Observations	Comments
1	Is there an internal Electrical Safety Audit & Inspection system? if so		Yes / No	
	i) Is there a formal procedure for it?		Yes / No	
	ii) What is the frequency?			
	iii) Produce a copy of the last internal Electrical Safety audit report.			

	iv) The recommendations of Electrical Safety inspections carried out were done		Yes / No	
	v) Procedure a copy of the last internal Electrical Safety Inspection report and it’s compliance			

C. GENERAL

Sr. No	Points	Clause No	Observations	Comments
1	Is any overhead line/ underground cable crossing your site ?		Yes / No /NA	
	Is there any work need to be carried out nearby that ?		Yes / No	
	If so, are the workers trained to do so?		Yes / No	
	Is precaution measures taken?		Yes / No	

D. ELECTRICAL INSTALLATIONS

1	Do all Electrical installations confirm to relevant standards and codes of practice?		Yes / No	
2	Are using fire resistant/ flame retardant cables for the tunnels? (Give Details)		Yes / No /NA	
3	Have you had any oil cooled transformers having oil quantity exceeding 2300 liters? If so:		Yes / No	
	i) Have segregated these transformers from adjoining cubicles by means of baffle walls/wired-glass windows in steel frame?		Yes / No	
	ii) Have provided appropriate soak pits for soaking up of leakages of oil?		Yes / No	
4	Motors are having over current protection systems and single phase preventor.		Yes / No	
5	i) Have battery-charging room?		Yes / No	
	ii) Is the battery charging room area well ventilated to prevent accumulation of hydrogen evolved?		Yes / No	
	iii) Is the area is free of ignition source?		Yes / No	
	iv) Is the battery chargers inspected regularly?		Yes / No	
	v) Is the eye wash station provided within 50 feet?		Yes / No	
6	Do you use High Rupture Capacity (HRC) fuses?		Yes / No	
7	Do you use Auto Circuit breakers for circuit breakers carrying current above 30mA and not depend on fuses only?		Yes / No	
8	Have you installed lighting arrestor as per requirement?		Yes / No	

E. DBs & SDBS

Sr. No	Points	Clause No	Observations	Comments
1	Are all panel, Plugs and sockets of IP44 type?		Yes / No	

2	Is earth conductor continued up to DB/SDB?		Yes / No	
3	Are suitable CBs provided at main & Sub-boards?		Yes / No	
4	Are they having clear access?		Yes / No	

F. ELCB

1	Whether the connections are routed through ELCB?		Yes / No	
2	Is the ELCB tester available?		Yes / No	
3	Are the ELCB/GFCI/RCCB numbered and tested?		Yes / No	
	Are they having clear access?		Yes / No	
	i) Mention the frequency			
	ii) Is ELCB /RCCB sensitivity maintained well within 30 mA and corresponding tripping time?		Yes / No	
	iii) Is test results recorded in a logbook countersigned by the site in-charge/ safety personnel? (Submit those details)		Yes / No	

G. DG SETS

1	Are they provided as per norms? (Access, foundation, spacing)		Yes / No	
2	Are flammable materials away from it?		Yes / No	
3	Are they provided with sufficient stack height?		Yes / No	
	Is the joints and top of the stack as per standard?		Yes / No	
4	Are loading of oil is done with the provision of drip tray?		Yes / No	
5	Are the cotton wastes from cleaning of fuel leakage tray disposed properly ?		Yes / No	
6	Whether the noise is monitored and controlled?		Yes / No	
7	Is it given with clear notification of emergency switch ?		Yes / No	
8	Are they having insulation mat before their panel?		Yes / No	
9	Are the earth pits of DG maintained properly?		Yes / No	
10	Whether you are having any portable generators?		Yes / No	

H. ILLUMINATION

Sr. No	Points	Clause No	Observations	Comments
1	Is sufficient illumination maintained throughout the site (Details of illumination)		Yes / No	
2	Are the lighting poles provided without causing any hazard?		Yes / No	

3	Are the plugging arrangements made properly?		Yes / No	
4	Emergency lighting provided wherever required (emergency operations/exits/tunnels/ access areas)		Yes / No	
5	Is tunnel lighting installed as per standard?		Yes / No	
	i) Is proper illumination maintained?		Yes / No	
	ii) What is the checking frequency of emergency light fittings to the normal fittings ?			
	iii) How frequent lighting arrangement is checked?			

I. CABLES

1	Mention the frequency of cable checking.			
2	Are cables received from other site / previous site checked for insulation resistance before putting them into use?		Yes / No	
3	Are welding cables routed properly above the ground and without overlapping with cables?		Yes / No	
4	Is any improper joining of cable wires prevailing at site?		Yes / No	
5	Whether all flexible cords with a conductor cross sectional area greater than 1.5 mm^2?		Yes / No	
6	Are all cables taken underground are armoured?		Yes / No	
7	Is mechanical protection given for armoured cable?		Yes / No	
8	Is convenient means of suspension above 6m of ground is given for cable crossing open area of span over 3m?		Yes / No	
9	Are there any loose connections?		Yes / No	

J. EARTHING

Sr. No	Points	Clause No	Observations	Comments
1	Is neutral earthing ensured at the source of power (Main DB at Gen. or Transformer)?		Yes / No	
2	Whether the continuity & tightness of earth conductor are checked?		Yes / No	
3	Mention the gauge of earth conductor used at site.			
4	Mention the value of earth resistance maintaining at site. (Provide the details)			
5	Whether Electrical equipment's earthed by suitable means?		Yes /No	
6	Whether the barricaded are earthed ?		Yes /No	
7	Whether all the temporary structures were earthed?		Yes /No	
8	Is min. distance of 3m between the earth pits maintained ?		Yes /No	

K. ELECTRICALLY OPERATED MACHINES & ELECTRICAL INSTRUMENTS

1	Are instructions and operating manuals available ?		Yes / No	
2	All handheld power tools have auto cut-off switch?		Yes / No	
3	Are portable power-tools made double insulated and marking towards that visibly exits at all tools		Yes / No	
4	Are damaged equipment's labeled " Do Not Use" and red tag on it		Yes / No	
5	Are the vibrating tools provided with vibrating mounting ?		Yes / No	
6	Are blades, bits, and other cutting parts sharp and well fixed, and not worn, cracked or loose?		Yes / No	
7	Are tools stored in a dry and safe places?		Yes / No	
8	Are there sign of overheating?		Yes / No	
9	Are the welding cables are maintained / checked properly ?		Yes / No	
10	Whether the welding work to be carried out in confined space?		Yes / No	
	If so, is every welding personnel trained so?		Yes / No	
11	Is suitable fire extinguisher ready to use?		Yes / No	
12	Are the welding rods are properly disposed?		Yes / No	
13	Are the ON & OFF is provided with clear indication?		Yes / No	
14	All instruments properly calibrated and labeled (check calibration schedule and records)		Yes / No	
15	Circuit breakers adequate for circuit protection or not		Yes / No	
16	Emergency disconnect switches properly marked		Yes / No	

L. ELECTRICAL PPEs & HOUSEKEEPING

Sr. No	Points	Clause No	Observations	Comments
1	Is there a laid down system of availability, use and maintenance of Electrical personal protective equipment's (PPEs)		Yes / No	
2	Are there adequate Electrical PPEs made available and workmen do use them, wherever required?		Yes / No	
3	Are Electrical PPEs selected in consultation with workmen using the same and the Safety department?		Yes / No	
4	Are there sufficient Electrical insulation mats of ISI marking for specified voltage conditions available?		Yes / No	
5	Is Resuscitator for Electrical Shock treatment available?		Yes / No	
6	Area all electrical area floors and stairways in good condition (no damaged, lean and non-slippery)		Yes / No	

M. ELECTRICAL MAINTENANCE

1	Is there any system of monitoring and predicting equipment condition and undertake electrical preventive maintenance ? (Give details)		Yes / No	
2	Is there a system of scheduled Electrical maintenance and overhauling ? (Give Details)		Yes / No	

N. TRAINING & TOOLBOX TALK

1	Is training conducted on electrical safety and recorded? (Provide training details)		Yes / No	
2	Does training include general rules to be followed at site?		Yes / No	
	Whether it is given based on standard /safe working practices?		Yes / No	
3	Are the training provided to the electrical equipment operators?		Yes / No	
4	Whether refresher training is given to the operators?		Yes / No	
	What is the frequency?			
5	Cardiopulmonary resuscitation (CPR) training provided to electricians? If so		Yes / No	
	a) Course details			
	b) Name of the trainer			
	c) Course contents			
	d) Course duration			
6	Is task specific toolbox talk is provided?		Yes / No	
	Provide the details of previous such activities		Yes / No	

O. WARNING SIGNS

Sr. No	Points	Clause No	Observations	Comments
1	Warning/ Danger signs displayed at DG, DBs, SDBs, etc?		Yes / No	
2	Are they informative /realistic / animated ?		Yes / No	
3	Is information on " FIRST AID FOR ELECTRICAL SHOCK (CPR)" is displayed in the site		Yes / No	

The inspection has been done in my presence and observations are noted.

Safety & Health (Electrical) Manager ESHS Manager

Attachment -5 Safe Work Procedure for Work Near Railway Track

1.0 Safety precautions and measures to be observed during execution of ROB/ RUB/ Viaduct/ any other works in Railway and adjoining areas:

1.1 The Contractor(s) shall not allow any road vehicle belonging to him or his suppliers, etc. to ply in HRIDC/railway land next to the running line. If for execution of certain works viz. earthwork for parallel railway line and supply of ballast for new or existing rail line gauge conversion, etc. road vehicles are necessary to be used in railway/HRIDC land next to the railway line, the Contractor(s) shall apply to the Engineer-in-Charge for permission giving the type and number of individual vehicles, names and license particulars of the drivers, location, duration and timings for such work/movement. The Engineer-in-Charge or his authorized representative will personally counsel, examine and certify the road vehicle drivers, Contractor(s)' flagmen and supervisors and will give written permission giving names of road vehicle drivers, Contractor(s)' flagmen and supervisors to be deployed on the work, location, period and timing of the work. This permission will be subject to be following obligatory conditions:

1.2 Construction Activities and Safety:

a) The 'Methodology of Working' shall be incorporated in GAD and Temporary Arrangement Drawings.

b) The activities of work to be taken up during the railway traffic block/under speedrestriction, etc. should be clearly mentioned in such drawings. If at any stage of execution, any discrepancy is found in the drawing with respect to the site condition affecting safety or some new activity of work is required to be done, the same should be brought to the notice of Railway & HRIDC Engineers and such works should be done only after approval by Railways & HRIDC representative. In such cases, scheme may be modified and, if required, fresh CRS sanction shall have to be obtained.

1.2.1 The works required to be done under traffic block protection, are to be carried out only in the presence of Railway & HRIDC Engineering Officials. The Railway's and HRIDC's Supervisor has to certify safe conditions for passage of trains before resumption of traffic. The works to be done under traffic shall be carried out under the provision of banner flag and protection by Engineering Flagman.

1.2.2 Following important activities of works shall be carried out under supervision of Railway/HRIDC Engineer or his nominated Supervisor:

a) Excavation at foundation/ground level near to railway track

b) Concrete casting and/or masonry work very close to railway track

c) Erection of temporary structures near to running lines.

d) Casting of structures like girder/slab over railway track

e) Stage-prestressing of girders when placed across railway tracks properly supported

f) Launching of precast/pre-assembled girders across railway tracks

g) Any work of lifting, side shifting and slewing of girders over the railway track

h) Dismantling of temporary structures, shuttering, scaffolding, etc. adjacent to and above the railway track. For carrying out activities of casting, erection, launching, handling, and dismantling as listed above, the Contractor's Engineer shall furnish the Construction Programme in advance to HRIDC Supervising Engineer & Engineer representative. No such work should be taken up in absence of the HRIDC Supervising Engineer & Engineer representative. For the activities which are to be done in presence of the HRIDC Engineer and prior intimation shall be given in writing and acknowledgement obtained from HRIDC's representative.

1.2.3 To ensure 'Safety' during construction activities, HRIDC site Engineer & Engineer representative may direct the Contractor's Supervisor/Engineer or their nominated representative for safe working procedures/ instructions, notwithstanding the contractual or MOU conditions prevailing between/ among Railways/other Departments like NHAI/Contractors/ Concessionaire.

1.2.4 All the records of Quality Assurance/Quality Control, testing of the materials and satisfactory completion of an activity shall be maintained at site by the Contractor's Engineer and Supervisor. On the basis of these records, HRIDC site Engineer shall do stage-wise clearance of the works at following stages:

i) Completion of foundation
ii) Completion of substructure
iii) Completion of superstructure

Without such stage clearance, the work in next stage of construction shall not be allowed by the HRIDC Supervisor, unless proper system of check and exercise is followed at the site.

1.2.5 Normally, the high beam PSC girders are designed with wider top flange and shorter bottom flange with very high beam which makes the girder unsuitable during lowering, slewing and launching time.

1.2.6 During launching of girders and subsequent adjustments for placement of bearing, special attention and precautions are required at site to be followed rigorously without resorting to shortcut practice or leaving the work at site to untrained or inexperienced Engineers. Normally, end diaphragms are not cast for the extreme both side girders. These shall be cast minimum 300mm on both sides for all 'I' beam girders to provide temporary supports for ensuring stability.

"OR"

For side adjustments and bearing placements below 'I' section girders, end brackets made of steel angles should be provided for all 'I' beams sequentially to avoid side titling of individual girders. End brackets shall be removed only after placing girders on bearing and casting of diaphragms.

1.2.7 During lowering, the jacks shall be operated duly keeping wooden packing of various thicknesses fixing the amount of lowering to the barest minimum, so that even if the jack fails, the wooden packing will take load and further stability of girder is not endangered.

1.2.8 Temporary crib support staging shall be interlaced with clamps and angles. Adequate base width shall be maintained proportionate to the height of stage, which is very essential for avoiding the oblong effect during launching of girders. During launching by RH girder method, the movement of the PSC girders shall be controlled both from front and rear with sync mechanism having simultaneous operation, so that the speed of the launching is always under the control. Spare hydraulic jacks shall always be kept at site. Lowering of girder shall always be carried out at one end only. Further, other end should be adequately secured by wire ropes, end brackets, etc. Thereafter, the process shall be continued alternately.

1.2.9 As far as possible, launching of girders by temporary staging shall be avoided and launching by heavy capacity cranes, wherever feasible, shall be adopted.

1.2.10 Steel girder launcher if used for launching of PSC girders should be pre-tested for the critical loading (likely to be encountered during actual launching) before deployment on the approaches regarding its strength as well as amount of permissible deflection using actual test PSC girder as a testing load. Connections at supports shall be inspected and certified prior to actual launching. It shall be adequately secured to the base support system on the pier cap.

1.3 General Construction Safety:

1.3.1 General safety precautions as applicable for civil works shall be adopted in field.

1.3.2 Working near running line: Safe practices at site and at all times non-infringement to moving trains shall be ensured. Road vehicles, material trolleys, dollies with any tendency to roll off towards the running lines to be checked by providing chains, locking arrangements, blocks, etc. shall be ensured and the site-in-Charge of the Contractor shall be primarily responsible, secondary responsibility being of Contractor's Consultant.

1.3.3 Testing of cranes, lifting jacks and other equipment: All equipment like cranes, lifting jacks shall be tested, duly calibrated and certified prior to the use at construction site.

1.3.4 Routine safety checks, validity of test certificates for load bearing equipment especially for cranes outsourced from third party shall be ensured prior to deployment.

1.3.5 Construction workers at site shall be provided with personal safety gear like reflective vest, helmet, Safety shoes, gloves & eyewear approved as per construction industry standards. For persons working at pier top/girder level, temporary supports, hand railing, protection with help of ropes, slings and temporary railings shall be provided.

2.0 Safety Guidelines and Precautions for working close to Railway tracks

2.1 A large number of men and machinery are deployed by the contractors for track renewals, gauge conversions, doublings, bridge rebuilding etc. It is therefore essential that adequate safety measures are taken for safety of the trains as well as the work force. The following measures should invariably be adopted.

A. The contractor shall not start any work without the presence of HRIDC Engineer at site.

B. Wherever the road vehicles and/or machinery are required to work in the close vicinity of railway line, the work shall be so carried out that there is no infringement to the Railway's schedule of dimensions. For this purpose, the area where road vehicles and/or machinery are required to ply, shall be demarcated and acknowledged by the contractor. Special care shall be taken for turning/ reversal of road vehicles/machinery withoutinfringing the running track. Barricading shall be provided wherever justified and feasibleas per site conditions.

C. The look out and whistle caution orders shall be issued to the trains and speed restrictions imposed where considered necessary. Suitable flagmen/detonators shall be provided where necessary for protection of trains.

D. The supervisor/workmen should be counseled about safety measures. A competency certificate to the contractor's supervisor as per Performa annexed shall be issued by DGM/HRIDC, which will be valid only for the work for which it has been issued.

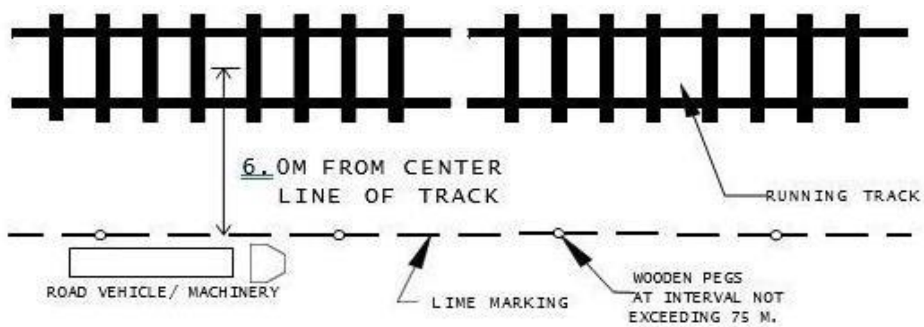
E. The unloaded ballast/rails/sleepers/other P-Way materials after unloading along track should be kept clear off moving dimensions and stacked as per the specified heights and distance from the running track.

F. Supplementary site-specific instructions, wherever considered necessary shall be issued by the HRIDC's representative.

2.2 PLYING OF ROAD VEHICLES AND WORKING OF MACHINERIES CLOSE TO RUNNING TRACKS

A. Normally, the road vehicles shall be run, or machinery shall be worked so as not to come closer than 6.0m from centre line of nearest running track.

B. The land strip adjacent to running tracks, where road vehicle is to ply or machinery is to work, shall be demarcated by lime in advance in consultation with the Railway's & HRIDC's Engineer. Wooden pegs at interval not exceeding 75mtr. shall be provided along the line marking as permanent marks. The road vehicles shall ply or machinery shall work so as not to infringe the line of demarcation.



C. If a road vehicle or machinery is to work closer to 6.0m due to site conditions or requirement of work, following precautions shall be observed:

a) In no case the road vehicle shall run or machinery shall work at distance less than 3.5m from centre line of track.

b) Demarcation of land shall be done by bright colored ribbon/nylon cord suspended on 120 cm high wooden/bamboo posts at distance of 3.5 m from centre line of nearest running track.

c) Presence of an authorized HRIDC's representative shall be ensured before plying of vehicle or working of machinery.

d) Railway's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train. Whistle boards shall be provided wherever considered necessary.

e) Lookout men shall be posted along the track at a distance of 800m from suchlocations who will carry red flag and whistles to warn the road vehicle/machinery users about the approaching trains.

f) On curves where visibility is poor, additional lookout men shall be posted.

D. If vehicle/machinery is to be worked closer to 3.5m from running track - Under unavoidable conditions, if road vehicles is to ply or machinery is to work closer to 3.5m due to site conditions or requirement of work, following precautions shall be observed:

a) Plying of vehicles or working of machinery closer to 3.5m of running track shall be done only under protection of track. Traffic block shall be imposed wherever considered necessary. The site shall be protected as per provisions of Para No. 806 & 807 of P-Way Manual as case may be.

b) Presence of a Railway's/, HRIDC's Supervisor shall be ensured at worksite.

c) Railway's& HRIDC's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train.

E. Precaution to be taken while reversing road vehicle alongside the track

The location where vehicle will take a turn shall be demarcated duly approved by Railway's/HRIDC's representative. The road vehicle driver shall always face the Railway track during the course of turning/reversing his vehicle. Presence of an authorized Railway/HRIDC representative shall be ensured at such location.

F. Road vehicle shall not be allowed to run along the track during night hours generally. In unavoidable situations, however, vehicles shall be allowed to work during night hours only in the presence of an authorized Railway's/HRIDC's representative and whereadequate lighting arrangements are made and where adequate precautions as mentioned earlier have been ensured.

G. Road vehicles/machinery/plant etc. when stabled near running tracks shall be properly secured against any possible roll off and always be manned even during off hours.

2.3 EXECUTION OF WORKS CLOSE TO OR ON RUNNING LINES

A. Any work close to or on running tracks shall be executed under the presence of a HRIDC's Supervisor only.

B. **Precaution to be taken to ensure safety of trains while execution of work close to the running line or on running lines**.

a) Such works shall be planned and necessary drawings particularly with regard to infringement to moving dimensions shall be finalized duly approved by competent authority before execution of work. The work shall be executed only as per approved procedure and drawings.

b) All temporary arrangements required to be made during execution of work shall be made in such a manner that moving dimension do not infringe.

c) Suitable speed restriction shall be imposed, or Traffic block shall be ensured as required. *The requirement of Traffic and Power Blocks shall be submitted by the Contractor to the Engineer for approval. The Traffic and Power Blocks will be finalized in consultation with Delhi Division of Northern Railway. No cost shall be charged for Traffic and Power Blocks from the Contractor*.

d) Necessary equipment for safety of trains during emergency shall be kept ready at site.

C. Precaution to be taken to ensure safety of electrical/signal/ telephone cables while excavating near tracks.

a) Particular care shall be taken to mark the locations of buried electrical/signal/telephone cables on the plans jointly with S & T/Electric supervisor and also at site so that these are not damaged during excavation.

b) Copy of the cable plan should be given to the contractor's authorized representative before handing over the site to start the work.

c) Due care shall be taken to ensure that any part of the equipment or machinery or temporary arrangement does not come close to cables while working.

d) Joint procedure order No. 17/2013 issued by Railway Board vide letter No.2003/Tele/RCIL/1 Pt IX dated 24.06.2013 shall be followed for undertaking digging work in the vicinity of underground signaling, electrical and telecommunication cables.

D. Precaution to be taken during execution of works requiring traffic blocks.

a) Any work, which infringes the moving dimensions, shall be started only after the traffic block has been imposed.

b) Before closing the work, the track shall be left with the proper track geometry so that the trains run safely.

c) After completion of work the released sleeper and fittings should be properly stacked away from the track to be kept clear of moving dimensions.

d) Block shall be removed only when all the temporary arrangement, machineries, tools, plants etc. have been kept clear of moving dimensions.

E. Precaution to be taken during execution of works during night:

The work close to running line, generally, shall be carried out only during day hours. At locations, however, where night working is unavoidable, proper lighting arrangement should be made. The engineering indicator boards shall be lighted during night hours as per the provisions of IRPWM. The staff deputed for night working should have taken adequate rest before deploying them in night shift. We can specify duration of night shift from 20.00 hrs to 04.00 hrs. All other safety precautions applicable for daytime work should be strictly observed during night working.

F. Precautions to be taken to ensure safety of workers while working close to running lines:

a) Necessary lookout men with red flags and whistles shall be provided to warn the workmen about the approaching train.

b) Railway's/HRIDC's supervisor shall issue suitable caution order to Drivers of approaching train for whistling to warn the workers about the approaching train. Whistle boards shall be provided wherever considered necessary.

c) A "First aid kit" shall always be kept ready at site

G. Precaution shall be taken for safety of public or passengers, while executing works at locations, used by passengers and public

The worksite shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as "Work in progress. Inconvenience is regretted" etc. shall be provided at appropriate locations to warn the public/ passengers. Adequate lighting arrangement of worksite wherever required shall be done to ensure safety of public/passengers during night.

H. Precaution to be taken before stacking materials alongside the track to ensure that safety of trains is not affected –

The following precautions shall be taken before stacking the materials along the track for stacking of ballast, rails, sleepers etc.

a) The sites for material stacking should be selected in advance in such a manner as to ensure that no part of the material to be stacked is infringing the Standard Moving Dimensions. A plan of proposed stacking locations be made and signed jointly by an authorized HRIDC's/Railway's representative and contractor's representative.

b) The selected locations shall be marked by lime in advance.

c) Presence of an authorized HRIDC's/Railway's representative while unloading and stacking shall be ensured.

d) The material shall be stacked in such a height so as to not to infringe SOD in case of accidental roll off.

I. Precaution for handling of departmental material trains –

Instructions for working of material trains are contained in Chapter VIII of IRPWM which should be brought to the notice of the supervisors and other staff working on the material trains. In addition to this,following precautions should be taken:

a) Issue of 'fit to run' certificate:

As per Para 848 before a material train is allowed to work, the complete rake should be examined by the Carriage and Wagon staff and a 'fit to run' certificate issued tothe Guard.

b) As per Para 849 of IRPWM, a qualified Engineering official should be deputed on the train to ensure working of the material train as the Guard is not qualified to carry out such duties like Supervising of loading and unloading of materials.

c) As per Para 845 of IRPWM, the material train should not be permitted to work during the period of poor visibility due to fog, storm or any other cause except with the permission of the ADEN/DEN. Working of the material trains carrying labour should not be permitted between sunset and sunrise except in an emergency.

d) While unloading rail panels by the side of the running track, placement of the panels, clear of the maximum moving dimensions should be ensured.

e) Unloading of rail panels should be done by a team of trained staff under the active supervision of competent Supervisor/Officer.

f) Before unloading of rail panels, site should be prepared by way of leveling/removing extra ballast, if any, from the crib and shoulder with the objective to ensure requisite lateral and vertical clearances so as to prevent slippage of rail panels due to vibration during the passage of trains.

g) Reasonably adequate block should be asked and provided for unloading of the material and the work should be done preferably in day light to avoid shortcut in haste which may infringe the safety requirements.

J. Safety aspects to be observed while working in OHE area

a) No electrical work close to running track shall be carried out without permission of HRIDC representative.

b) A minimum distance of 2m has to be maintained between live OHE wire and body part of worker or tools or metallic supports etc.

c) No electric connection etc. can be tapped from OHE.

d) Authorized OHE staff should invariably be present when the relaying work or any major work is carried out.

e) Power block is correctly taken and 'permit to work' is issued.

f) The structure bonds, track bonds, cross bonds, longitudinal rail bonds are not disturbed and if disconnected for the work, they are reconnected properly when the work is completed.

g) The track level is not raised beyond the permissible limit during the work

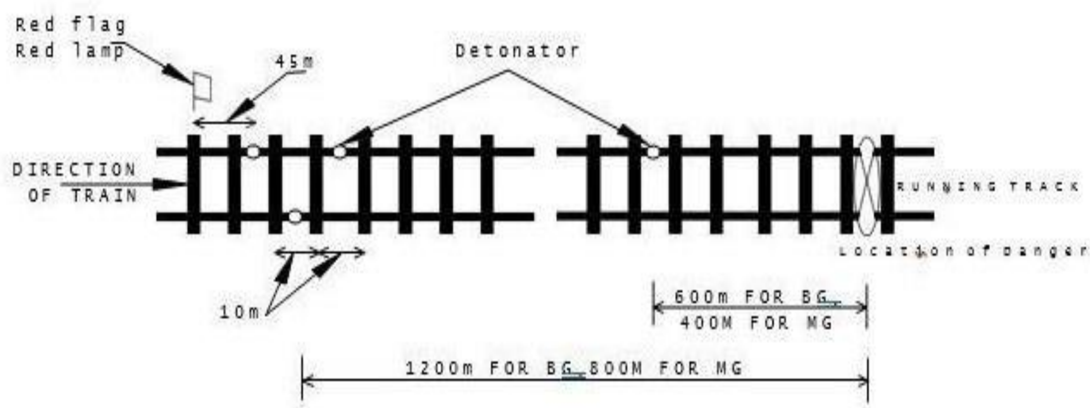
2.4 PROTECTION OF TRACK DURING EMERGENCY

A. Action to be taken when a contractor's supervisor or vehicle operator apprehends any unusual circumstances likely to infringe the track and endanger safe running of trains.

a) At any time if a contractor's supervisor or vehicle operator observes any unusual circumstances likely to infringe the track and apprehend danger to safe running of track, he shall take immediate steps to advise a HRIDC official of such danger and assist him in protection of track.

b) The track shall be protected as under. One person shall immediately plant a red flag (red lamp during night) at the spot and proceed with all haste in the direction of approaching train with a red flag in hand (red lamp during night) and plant a detonator on rail at a distance of 600m from the place of obstruction of BG track (400m for MG track) after which he shall further proceed for not less than 1200m from the place of obstruction from BG track (800m for MG track) and plant three detonators at 10m apart on rails. After this he shall display the red flag (red lamp during night) at a distance of 45m from the detonators.

c) Attempts shall also be made to send an advice to nearest Railway/HRIDC station about the incident immediately.



B. Action to be taken if train is seen approaching to site of danger and there is no time to protect the track as per guidelines mentioned above.

In such a case the detonators shall be planted on rails immediately at distance away from place of danger as far as possible and attention of driver of approaching train shall be invited by whistling, waving the red flag vigorously, gesticulating and shouting.

C. What action shall be taken if more than one track is obstructed.

a) In case of single line protection as above shall be done in both the directions from place of danger.

b) In case of double line or multiple lines, if other tracks are also obstructed, theprotection as above shall be done for other track also.

c) The protection shall be done in that direction and on that track first on which train is likely to arrive first.

d) The Contractor's Supervisors, Operators and lookout men shall be properly explained about the direction of trains on running tracks.

D. Equipment required for protection of track.

Minimum compliment of protection equipment i.e. 10 detonators, 4 red hand flags, 4 red

hand lamps, 4 banner flags and whistles etc. shall always be kept ready at worksites for use in case of emergency. HRIDC will arrange to provide detonators, whereas Contractor shall arrange other equipment at his own cost.

E. Arrangement of lookout men and competency required for lookout man to warn labour about approaching train.

a) Contractor will provide lookout men.

b) The lookout men shall be properly trained in warning to staff at worksite about approaching train.

c) Only those lookout men shall be provided at site who have been issued with a competency certificate by the Railway's/HRIDC's Supervisor.

d) In case, it is felt necessary to provide lookout men by Contractor, the charges for the same as fixed by HRIDC Administration shall be recovered from Contractor.

2.5 Training to Supervisors and Operators of Contractor

The Supervisors and Operators of the contractor proposed to be deployed at wok site, which is close to the running track, shall be imparted mandatory training by the HRIDC at site free of cost about the safety measures to be adopted while working in the vicinity of running track. HRIDC's Engineer-in charge of the work shall decide the scale, extent & adequacy of training. In case training is imparted at a recognized Railway training institute, the charges for the same, as decided by HRIDC, shall be recovered from the Contractor. A competency certificate to this effect to the individual Supervisor/Operator shall be issued as given below,by a HRIDC Officer not below the rank of DGM/HRIDC. No Supervisor/Operator of the Contractor shall work or allowed to work in the vicinity of running track that is not in possession of valid competency certificate.

All the labour, materials, tools, plants etc. except detonators, required for ensuring safe running of trains shall be provided by Contractor at his own cost. Wherever lookout men are provided by HRIDC, charges at the rate of Rs. 1000/- per man day shall be recovered from Contractor.

A sample of training competency certificate is provided below for reference:

Competency Certificate

Certified that Shri ………………………… Supervisor/Operator of M/s. …………………has been trained and examined in safety measures to be followed while working in the vicinity of running railway track for the work. His knowledge has been found satisfactory and he is capable of supervising the work safely.

This certificate is valid only for the work mentioned in this certificate only.

Signature and designation of the officer