Consolidated Bid Documents
For

INTEGRATED CONTRACT PACKAGE OF DESIGN AND CONSTRUCTION OF CIVIL, BUILDING AND TRACK WORKS FOR DOUBLE LINE RAILWAY INVOLVING FORMATION IN EMBANKMENTS/ CUTTINGS, BRIDGES, STRUCTURES, BUILDINGS, BALLAST ON FORMATION AND TRACK WORKS, DESIGN, SUPPLY AND INSTALLATION OF 2X25 kV TRACTION POWER SUPPLY SYSTEM, TRACTION SUB-STATIONS, AUXILIARY STATIONS, SWITCHING STATIONS, AUTO TRANSFORMER STATIONS AND SCADA SYSTEM AND DESIGN AND CONSTRUCTION OF SIGNAL AND TELECOM WORKS FOR DOUBLE LINE RAILWAY INVOLVING TRAIN DETECTION SYSTEM, ELECTRONIC INTERLOCKING IN STATIONS, BLOCK PROVING WITH AXLE COUNTERS, INTERMEDIATE BLOCK SIGNALLING (IBS), TRAIN MONITORING & DIAGNOSTIC SYSTEM (TMS), , DISPATCH TELEPHONE SYSTEM, FIBER OPTIC COMMUNICATION SYSTEM, GSM(R) SYSTEM, DIGITAL ELECTRONIC EXCHANGE SYSTEM AND MASTER CLOCK SYSTEM INCLUDING TESTING AND COMMISSIONING ON DESIGN-BUILD LUMP SUM PRICE BASIS FOR REWARI - DADRI SECTION OF WESTERN DEDICATED FREIGHT CORRIDOR (PHASE-2)

INTEGRATED CONTRACT PACKAGE OF CIVIL, BUILDING AND TRACK WORKS, ELECTRICAL AND MECHANICAL WORKS AND SIGNALLING AND TELECOMMUNICATION WORKS

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VOLUME-III (Part C)
Employer's Requirements (Signalling &Telecommunication Systems)
(Particular Specifications)

Employer:
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

MINISTRY OF RAILWAYS
INDIA

CONSOLIDATED BID DOCUMENTS

for

Dedicated Freight Corridor Project
(Western Corridor, Phase 2: Dadri – Rewari & Vadodara-JNPT)

INTEGRATED CONTRACT PACKAGE OF CIVIL, BUILDING AND TRACK WORKS, ELECTRICAL AND MECHANICAL WORKS AND SIGNALLING AND TELECOMMUNICATION WORKS

Contract Package 14

ICB No. CT P-14: Rewari – Dadri Section

VOLUME III (PART C)

Section 9 (Part C) - Employer's Requirements (Signalling & Telecommunication Systems)

(Particular Specifications)

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1. SCOPE OF WORKS

1.1 General

1.1.1 The main purpose of Signalling is to secure the safety of train operation in all the lines and to realize the efficient traffic in order to provide an undisturbed transportation service to the public.

1.1.2 The Contract shall comprise design, supply, factory testing, installation, integration with other contracts, site testing, commissioning, training and defects liability of the Signalling system.

1.1.3 All stations, Block sections, Level Crossing gates and Operation Control Centre (OCC) shall be equipped with Signalling system.

1.1.4 The Contractor shall integrate signalling system of DFCCIL with that of IR seamlessly so that there is interoperability between the two systems.

1.2 Relevant Documents

1.2.1 This Particular Specification (PS) shall be read in conjunction with the General Conditions of Contract (GCC), the General Specification (GS) – Vol. II Part C and any other document forming part of the Contract.

1.2.2 In the event of a conflict between the GS and the PS, the requirements of the PS shall prevail.

1.2.3 In the event of a conflict between this Particular Specification and any other standards or specification quoted herein, the requirements of this Specification shall prevail. The order of precedence, with item a) having the highest priority, is:

a) Employer's Requirements - Particular Specification
b) Employer's Requirements - General Specification – Vol. II Part C
c) Indian Standards
d) International Standards referenced herein.
e) Other International Standards
f) Other National Standards.

1.2.4 Notwithstanding the precedence specified, the Contractor shall always immediately seek advice from the Engineer in the event of any conflict between above items.

1.2.5 The contents on these standards shall be considered along with its latest amendments as on base date.

1.2.6 Notwithstanding the contents of Sections 1.2.1 and 1.2.2 above, the Contractor shall always immediately seek advice from the Engineer in the event of any conflict between specifications

1.3 Employer's Requirements

1.3.1 The Contractor shall provide a Signalling system for all the lines and all stations including Operation Control Centre (OCC). The Signalling system shall have mainly the function of Train Detection (TD), Electronic Interlocking (EI) in stations, Block

Proving with Axle Counters (BPAC), Intermediate Block Signalling (IBS) in long Block sections, Interlocking of Level crossing gates and Train Monitoring and Diagnostic System (TMS). The Signalling system shall be constructed to conform to the Employer's Requirements and other internationally recognized standards and shall be designed for secured system.

1.3.2 The Contractor shall coordinate with Bridge contractor (Package 15C) for detailed interface requirements on the railway route alignment and main line track layout in accordance with Employer's Requirements and other design criteria.

1.3.3 The Contractor shall design the signalling system based on the system operation and maintenance plan, IEC and / or equivalent international standards specification. These will be as described in General Specification – Vol. II Part C of Package 14.

1.3.4 The redundant data transmission system with ring configuration shall be utilized for communication between stations including IBS Locations and OCC. The data transmission shall utilize the Optical Fiber Network as referred to in section of Telecommunication System, Part 2 of PS.

1.3.5 All the functions on the data transmission shall be protected against unauthorized operation by the Area Of Responsibility (AOR) mechanism.

1.3.6 NOT USED.

1.3.7 The Service Life for the Signalling system shall be more than twenty (20) years with the need for refurbishment running not less than ten (10) years into this period.

1.3.8 Connections to IR, EDFC & sidings:

(a) The tracks connecting DFCCIL Junction stations with IR/EDFC stations shall be provided with Absolute Block Signalling with block/ slot working. Where such track lengths are less than 4 Kms, any of block/ slot working may be adopted. For longer track lengths, Absolute Block working using Block Proving by Axle Counter using UFSBI as per RDSO Specification No. IRS: S 105 shall be provided.

(b) Wherever sidings connected to IR stations shall get the connection transferred to DFCCIL stations, existing system of Block/ Slot working shall be transferred from IR station to DFCCIL station

(c) Details of Connections to IR, EDFC & Sidings are given in Vol. V of Bid Documents.

1.3.9 Manufacturer and provenness details of all locally procured major Signalling equipment (if not appearing in RDSO's approved list of vendors) shall be submitted as part of Bid offer.

1.3.10 Cross Acceptance of major imported Signalling Equipment:

(a) Manufacturer & provenness details and Cross Acceptance approval (by RDSO/DFCCIL) status of all major imported Signalling equipment e.g. EI, MSDAC etc. shall be submitted in Form I-B-7 (S&T), Volume I (1/2) of Bid documents.

(b) If any such equipment is not yet having Cross Acceptance approval, the Contractor shall get the same done as per RDSO/ DFCCIL's Cross Acceptance Procedure. DFCCIL's Cross Acceptance Procedure is kept at Annexure 10.

(c) The Contractor shall be responsible for timely action on all items related to Cross Acceptance so that approval is available well in time to achieve Contract Milestone MS-2. Some of these, but not limited to, are as under:

(i) Submission of Safety Case & other documents to ISA with copy to the Employer & the Engineer.

(ii) Submission of type test plan.

(iii) Conduct of type tests.

(iv) Submission of type test report.

(v) All items related to field trial including Submission of report. Responsibility Matrix for Cross Acceptance Procedure kept at Annexure 11 shall be followed.

1.3.11 The Contractor shall prepare a plan that shall identify in detail the sequence of testing that shall include as a minimum the evaluation of prototypes at the Contractor's factory and testing of prototype equipment in the normal sequence of factory and on-site testing for production of equipment.

1.3.12 The Contractor shall prepare a plan in accordance with the Employer's Requirements that shall be presented for the Engineer's review and shall as a minimum describe the content, duration, timing and location of all training activities proposed by the Contractor.

1.3.13 The Contractor shall prepare and supply all necessary training documentation and operating and maintenance manuals for the review of the Engineer.

1.3.14 Name of entity proposed to be responsible for Signalling System Integration shall be submitted by the Bidder in Form I-B-5 (S&T), Volume I (1/2) of Bid Documents.

~~1.3.14~~**1.3.15** P14 Contractor shall provide Signalling arrangement for controlling train movements upto the point where WDFC track ends both on New Boraki (EDFC) and Dadri (IR) side stations.

1.4 System Overview

1.4.1 The Signalling system shall consist of following sub-systems or equipment as minimum requirement. In accordance with the requirement, the Contractor shall propose appropriate system configuration with sub-system or equipment for review by the Engineer.

1.4.2 Main Line and Depot access Line:

1) All main and running lines information shall be conveyed to OCC;
2) Block Proving With Axle Counters.
3) Electronic Interlocking system (Refer list of stations at Annexure 3)
4) Intermediate Block Signalling in long Block Sections having inter station distance of more than 30 Kms.

5) Interlocking of Level Crossing Gates (Refer list in Data Book Vol. IV of Bid Documents)
6) Train Detection system;
7) Data Transmission System;
8) Train Monitoring and Diagnostic System (for phase 2 stations including Block sections as per Annexure 3);
9) Power Supply System (PSS);
10) Point machines and
11) Other necessary equipment.

1.4.3 OCC:

1.4.3.1 TMS including PSS, Rear Projection System and other necessary equipment for OCC shall be initially provided by ST P-5 Contractor for Rewari – Makarpura section of Phase 1. CT P-14 Contractor shall provide Rear Projection System and other necessary equipment for Dadri – Rewari section of Phase 2 to get an integrated TMS system as per details given in Annexure 7-3.

1.4.3.2 The trains on main and running lines shall be all supervised in OCC. All routes setting shall be carried out at local stations. All necessary data shall be collected in OCC. Refer Annexure 1 and Annexure 2 for FRS and Technical specs of TMS respectively.

1.4.3.3 TMS terminals shall be provided at designated places of IR/EDFC to enable IR/EDFC to give weekly forecast of trains coming in from IR/EDFC to WDFC to enable WDFC to prepare time table. This will be reviewed daily and any changes required shall be carried out manually by OCC. These terminals are included in the Misc. User terminals listed in next Clause.

1.4.3.4 5~~4~~ No. of Miscellaneous user terminals shall be provided with its location and quantity tentatively fixed as under:

IR's Junction stations: 2

IR's Divl. Control Offices: 1

IR's Zonal Control Offices: 1

For IR's terminals connectivity, the Contractor shall provide OFC upto Junction stations details of which shall be finalized during Interface with IR/EDFC.

1.4.3.5 No new Training server/ terminals & Controller's terminals will be added in OCC for Dadri – Rewari section.

1.4.3.6 Following minimum systems shall be provided in OCC:

1) Rear Projection System for traffic supervision
2) Interface equipment
3) Other necessary equipment

1.4.4 NOT USED

1.4.5 Crew Lobbies & Signal Maintenance Base:

1.4.5.1 Maintenance Base will be in designated IMDs & sub-depots. Similarly there will be designated Crew Lobbies for booking of drivers.

1.4.5.2 Following minimum system shall be provided in Crew Lobbies & Signal Maintenance Bases.

1) TMS terminal;
2) Other Necessary Equipment.

1.5 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 the Signalling system and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters shall lie with the Contractor.

* * * End of Chapter 1 * * *

2. DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

In this Particular Specification, the following defined terms shall have the meanings described below:

Definitions	Descriptions
Availability	The probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that the given external resources are provided.
Design Life	The design life of the Signalling and Train Control System is the period of time during which the item is expected to work within its specified parameters; in other words, the life expectancy of the system.
Main Line	The DFCCIL line between JNPT and Dadri station.
Depot access line	The line between Main Line and Depot entrance.
Depot	All the area for Electric Loco Maintenance including stabling tracks, shunting tracks, work station, test track, inspection track, Loco washing track, wheel re-profiling track and maintenance berths from Depot entrance to these tracks.
Sub-system	Each system comprising signalling system for example EI, TMS and so on.
Train Number	Alphanumeric number uniquely identifying a running train.
Console	MMI device with video display, keyboard and mouse for Traffic Controller and Assistant station Master.
Mimic panel or Video wall	A graphical representation of the railway and its global operating status.

2.2 Abbreviations

Abbreviations used in this Particular Specification are as listed below:

ACTM	Alternating Current Traction Manual
ARO	Area Of Authority
ARS	Automatic Route Setting
ASCII	American Standard Code for Information Interchange
ASM	Assistant Station Master
ATS	Automatic Transfer Switch
BCC	Backup Control Centre
BPAC	Block Proving by Axle Counter
CD	Compact Disc
CENELEC	European Committee for Electrotechnical Standards (Comite Europeen de Normalisation Electrotechnique)

CHC	Chief Controller
CITT	International Telegraph and Telephone Consultative Committee
CKD	Completely Knocked down
CMS	Crew Management System
CTC	Centralised Traffic Control
CTR	Cable Termination Rack
CV	Curriculum Vitae
DAC	Digital Axle Counter
DAT	Digital Audio Tape
DBMS	Data Base Management System
DCC	Depot Control Centre
DLP	Defect Liability Period
DLP	Digital Light Processing
DMI	Driver Machine Interface
DSS	Decision Support System
DTS	Data Transmission System
Dy. CHC	Deputy Chief controller
EI	Electronic Interlocking
ELMD	Electric Loco Maintenance Depot
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EPROM	Erasable Programmable Read Only Memory
ETCS	European Train Control System
FAT	Factory Acceptance Tests
FIU	Field Interface Unit
FRACAS	Failure Reporting and Corrective Action System
FRS	Functional Requirement Specification
G & SR	General and Subsidiary Rules
GCC	General Conditions of Contract
GPS	Global Positioning System
GS	General Specification
GSM(R)	Global System for Mobile communication (Railway)
HDD	Hard Disk Drive
HDPE	High Density Poly Ethylene
I/O	Input Output
IBS	Intermediate Block Signalling
IC	Integrated Circuit
ID	Identification
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineering
IGBT	Insulated Gate Bipolar Transistor
IMD	Integrated Maintenance Depot
IPMI	Intelligent Platform Management Interface
IR	Indian Railways
IRJ	Insulated Rail Joint
IRPWM	Indian Railways Permanent Way Manual
IRSEM	Indian Railways Signal Engineering Manual
ISA	Independent Safety Assessor
ISO	International Standards Organization
ITU	International Telecommunications Union
JE	Junior Engineer
JIS	Japanese Industrial Standard

JNPT	Jawahar Lal Nehru Port Trust
LAN	Local Area Network
LBS	Local Bus Synchronisation
LC	Level Crossing
LCD	Liquid Cristal Display
LED	Light Emitting Diode
LEU	Lineside Electronic Unit
MIS	Management Information System
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MMI	Man Machine Interface
MSDAC	Multi Section Digital Axle Counter
MTBF	Mean Time Between Failure
MTBMA	Mean Time Between Maintenance Action
MTRC	Mobile Train Radio Communication
NDA	Non Described Alarm
NMS	Network Management System
O&M	Operation and Maintenance
OBC	On Board Computer
OCC	Operation Control Centre
OEM	Original Equipment Manufacturer
OFC	Optical Fibre Cable
OHE	Over Head Equipment
ORP	Overrun Protection
PC	Personal Computer
PLC	Programmable Logic Controller
PS	Particular Specification
PSS	Power Supply System
PTR	Proven Track Record
PVC	Poly Vinyl Chloride
RAID	Redundant Array of Independent Discs
RAM	Random Access Memory
RAMS	Reliability, Availability, Maintainability and Safety
RDSO	Research, Design & Standards Organisation
RE	Railway Electrification
SATA	Serial Advanced Technology Attachment
SCADA	Supervisory Control And Data Acquisition
SCOR	Section Controller
SCR	Silicon Controlled Rectifier
SCSI	Small Computer System Interface
SE	Sectional Engineer
SER	Signal Equipment Room
SKD	Semi Knocked Down
SNMP	Simple Network Management Protocol
SOD	Schedule of Dimensions
SQL	Structured Query Language
TBD	To Be Decided
TC	Traffic Controller
TCP/IP	Transfer Control Protocol / Internet Protocol
TD	Train Detection
TDS	Train Describer System
TMS	Train Monitoring and Diagnostic System
TPC	Traction Power Controller
TOT	Transfer Of Technology

TPWS	Train Protection & warning System
TSR	Temporary Speed Restriction
TVSS	Transient Voltage Surge Suppressor
UART	Universal Asynchronous Receiver/Transmitter
UIC	International Union of Railways
UXGA	Ultra eXtended Graphic Array
VDU	Visual Display Unit

* * * End of Chapter 2 * * *

3. DESIGN CRITERIA AND STANDARD

3.1 Basic Design Philosophy and Requirements

3.1.1 Proven Design

(a) The Contractor shall develop the design based on this Technical Specification. The design details shall be submitted with technical data and calculations to the Engineer for approval.

(b) The Signalling and Train Control System including all sub-systems and equipment shall be of proven design. The system/sub-system, equipment, hardware and software proposed by the Contractor shall have been in use and have established their satisfactory performance over a period of at least two years on the worldwide railway/metro/monorail systems during last five years.

(c) Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipment.

(d) In case stipulations (a) and (b) are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered Sub-system to the satisfaction of the Engineer.

3.1.2 The design philosophy shall meet the following criteria:

(i) Application of state-of-the-art Technology;
(ii) Service proven design;
(iii) NOT USED;
(iv) Minimum life cycle cost;
(v) Ease of maintainability & inbuilt fault diagnostics;
(vi) Use of interchangeable, modular components;
(vii) Extensive and prominent labelling of parts, cables and wires;
(viii) Use of unique serial numbers for traceability of components;
(ix) High reliability;
(x) Energy efficiency;
(xi) System safety;
(xii) Adequate redundancy and factor of safety;
(xiii) Use of fire retardant materials for OCC & On board equipment wiring;
(xiv) Environment friendly;
(xv) Adherence to functional, operational and performance requirements;
(xvi) Open Architecture for integration with other Systems and
(xvii) Ease of expansion and integration.

3.1.3 Adequate margin shall be built into the design particularly to take care of the environmental considerations prevailing in Delhi NCR, Haryana, Rajasthan and Uttar

Pradesh.

3.1.4 The CV's of the key design personnel shall be provided to the Engineer for prior approval.

3.2 Design Criteria

3.2.1 Track Vacancy Detection System shall consist of Multi Section Digital Axle Counters.

3.2.2 Electronic Interlocking system shall be Hot standby and computerized based on the principle of fail safe.

3.2.3 All Level Crossing gates shall be provided with Electric Lifting Barriers and interlocked. Please refer Data Book Vol. IV of Bid Documents for list of Level Crossing gates. Wherever Level Crossing gate serves both DFCCIL and IR tracks together, the work will be suitably coordinated with IR.

3.3 Design Standard

3.3.1 For the Signalling system, the generic standards or other equivalent standards and standards which are specified in following shall be applied.

a) RDSO, Research, Design and Standards Organization, Ministry of Railways, India.

b) IEC: International Electro-technical Commission

c) ISO: International Standards Organization

d) JIS: Japanese Industrial Standard

e) JEITA: Japan Electronics and Information Technology Industry Association

3.3.2 For the signalling system, standards as given below, but not limited to, shall be followed.

S. No.	Standard	Description
1	EEIG: 97s066	ERTMS/ETCS Environmental requirements
2	IEC 60364	Electrical Installations for Buildings
3	IEC 60529	Degrees of protection provided by enclosures (IP Code)
4	IEC 60571	Electronic Equipment Used on Rail Vehicles
5	IEC 61373	Railway Applications – Rolling stock equipment – Shock and vibration tests
6	IEC 61992	Railway applications – Surge arresters and low-voltage limiters for specific use in d.c. systems
7	IEC 62236	Railway Applications – Electromagnetic compatibility (EMC)
8	IEC 62278	Railway Applications- Specifications and demonstration of Reliability, Availability, Maintainability & Safety.
9	IEC 62279	Railway Applications-Communications, Signalling and processing systems-Software for Railway Control and Protection Systems.

S. No.	Standard	Description
10	IEC 62280	Railway Applications-Communications, Signalling and processing systems - Safety related communication in transmission systems.
11	IEC 62305	Protection against Lightning
12	IEC 62425	Railway Applications-Communications, Signalling and processing systems- Safety Related Electronics Systems for Signalling.
13	IEC 62427	Railway Applications- Compatibility between Rolling Stock and Train Detection Systems
14	IEC 62505	Railway applications – Fixed installations – Particular requirements for a.c. switchgear
15	IRS: S 6	Tubular Steel Signal Poles
16	IRS: S 21	Electric Key Transmitter
17	IRS: S 23	Electrical and Electronic based Signalling and Interlocking Equipment
18	IRS: S 24	Electric Point Machine non trailable types
19	IRS: S 26	Colour light signal – Multi unit type
20	IRS: S 34	Testing Railway Signaling Relays (General)
21	IRS: S 36	Route Relay Interlocking systems.
22	RDSO/SPN/208	Electric Lifting Barrier
23	IRS: S 63	PVC insulated underground unscreened Signalling Cables for Railway Signalling
24	IRS: S 66	Route indicator, direction type 5 lamp unit arm (1 to 6 way)
25	IRS: S 76	PVC insulated indoor Cables for Railway Signalling
26	IRS: S 93(A)	Valve regulated (sealed) lead acid stationary battery & charger
27	IRS: S 99	Data Logger
28	IRS: S105	Block Proving by Axle Counter using UFSBI
29	IRS: TC 30	Underground Railway Jelly Filled Quad Cables for Signaling and Telecom Installations
30	RDSO/SPN/144	Safety and reliability requirement of electronic signalling equipment.
31	RDSO/SPN/153	LED signal lighting unit
32	RDSO/SPN/176	Multi Section Digital Axle counter
33	RDSO/SPN/177	Single Section Digital Axle counter
34	RDSO/SPN/189	Terminal Blocks, Fuse Terminal Blocks and Miniature Fuse Links of International Standard
35	RDSO/SPN/192	Electronic Interlocking
36	RDSO/SPN/197	Code of practice for earthing and bonding system for Signalling equipment
37	RDSO/SPN/203	Electronic Interlocking for Big Yards
38	RDSO/SPN/256	Earth Leakage detector
39	STS/E/Relays/AC Lit LED Signal/09	Universal plug-in type, tractive armature AC lamp proving relay (Metal to Carbon) for 110V AC LED Signal lamp

3.3.3 Following manuals shall be referred as required:

a) Indian Railways Signal Engineering Manual (IRSEM)

b) General and Subsidiary Rules (G&SR) of DFCCIL

c) AC Traction Manual (ACTM) of IR

d) Indian Railways Permanent Way Manual (IRPWM)

e) Schedule of Dimensions (SOD) of DFCCIL

3.4 System Assurance

3.4.1 The Contractor shall carry out system assurance to ensure that the requirements for safety, reliability, availability and maintainability for the signalling system are met.

3.4.2 System assurance activities shall include RAMS activities and the preparation of all supporting documentation. System assurance activities shall comply with the requirement in accordance with IEC 62278 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS).

3.4.3 System RAMS plan and its associated RAMS analysis work shall be undertaken at system level to demonstrate that the reliability, availability, maintainability and safety requirements are met.

3.4.4 The Contractor shall submit a RAMS report including result of internal audit by Contractor's organization or certification by third party verifier.

3.4.5 The Employer shall employ third party Independent Safety Assessor(s) (ISA) for Safety Assessment of certain imported signalling equipment (e.g. EI, MSDAC etc.) as per Cross Acceptance Procedure of DFCCIL and also certification of complete signalling system as per SIL requirements. The Contractor shall provide necessary documents and assistance to facilitate ISA's work.

3.4.6 The Contractor shall submit the report that the safety of TD System with Interlocking system meets SIL4 in IEC 62425 or equivalent safety level.

3.5 RAMS DEMONSTRATION

3.5.1 The Contractor shall be required to establish a personal computer based Failure Reporting and Corrective Action System (FRACAS) to demonstrate compliance with specified system and equipment reliability. It shall be a database system containing fields similar (but not limited to) "Signal failure Register" and facility to generate Management Reports as per requirement of Engineer/Employer.

3.5.2 The Contractor shall collect and maintain data on every Service Affecting Failure along with the data indicating the probable failure. The Contractor shall submit monthly RAM Demonstration Reports based on service failure data.

3.5.3 The failure of signalling system is defined as the failure of which cause is related to design, manufacture and/or installation of the Contractor except Operation and Maintenance.

3.5.4 The Contractor shall submit reliability calculations to confirm that the Signalling system meets reliability requirements.

3.5.5 In case the Contractor is not able to achieve the specified/provided RAMS targets, the Contractor shall take necessary corrective measures either by way of change of

design of the relevant equipment/component, software modification or change in maintenance regime at no additional cost to the Employer.

3.5.6 The Contractor shall analyse each and every failure/defect of components of various equipment to determine the cause of failure and to propose corrective measures. All these details shall be summarized in the investigation reports for Engineer's review and approval. The approved failure reports shall be retained as traceable record and maintained by using the computer based FRACAS.

3.5.7 The Contractor will be evaluated for RAMS demonstration during Defect Liability Period except initial 3 months beginning from revenue operation.

* * * End of Chapter 3 * * *

4. ENGINEERING CONDITIONS

4.1 Engineering Philosophy

The safety, the reliability and the maintainability required in signalling system shall consider the contents in IEC 62278 (RAMS) and IEC 62425 but need not to be constrained (it means including report of Independent Safety Assessor independent of contractor's design section as stated in chapter 3).

4.2 Safety Requirements

4.2.1 Concerning the safety of signalling system, IEC 62425 shall be referred but need not be constrained by it.

4.2.2 The safety level of TD system realized with working sub systems e.g. Interlocking system etc. shall satisfy the SIL4 or equivalent safety level.

4.2.3 TMS can have SIL0 or equivalent safety level.

4.2.4 The documents of safety principles related with above systems shall be submitted to Engineer.

4.2.5 Even when long power failure results in total drainage of PSS batteries, the signalling system shall be ready after Power-ON and initialization for use by ASM/Controller within two minutes of power restoration.

4.2.6 The Contractor shall show expected calculated failure rate related to above systems and show safe failures and hazard failures separately.

4.2.7 Accompanied to the documents, internal audit by Contractor's organization or audit by third party specialist shall be required.

4.3 Reliability Requirements

4.3.1 If failure of any sub-system is likely to adversely affect the train operation, the reliability shall be enhanced by providing redundancy in the equipment.

4.3.2 Duplicated system shall change uninterrupted when one system fails. If duplicated system has changing time, contractor shall show that its system shall not obstruct the train operation.

4.3.3 The Contractor shall submit calculation sheets in respect of all the sub-systems in the signalling system.

4.3.4 NOT USED.

4.3.5 The Signalling in Stations and Block sections shall be engineered for a minimum Service Life of 20 years, based on the equipment being continuously in operation, and shall achieve an MTBF of not less than 7 days for entire Dadri - Rewari section.

4.3.6 Porta Huts and Location Boxes shall be provided with required earth work for their stability as well as to facilitate maintenance work.

4.3.7 Trackside equipment e.g. Location boxes, Porta Huts etc. shall be designed and fixed with anti-theft measures.

4.4 Maintenance Requirements

4.4.1 Fundamentally, the system shall be designed based on the maintenance free concept.

4.4.2 The Contractor shall provide built-in diagnostics and remote monitoring functions for each equipment and module of the systems such that the performance can be demonstrated.

4.4.3 Monitoring system shall be so provided in order to support maintenance staff by suitable alarm generation message for predictive failure and if failure occurs, then they can locate the failure point with the data, transmitting/receiving signal levels recorded, operation record etc.

4.4.4 Each Location Box and other such standalone track side box shall be provided with its independent light to attend to failures during night time.

4.5 Electromagnetic Compatibility (EMC) Requirements

4.5.1 The overriding principle to be employed on the Project is safety by Design. No person shall be exposed to accessible voltage that exceeds the levels of International Standards, under normal operations or fault conditions.

4.5.2 The Contractor shall investigate the electromagnetic compatibility together with Rolling stock contractor regarding TD system in station area, and Block Sections after the installation of this system. Proximity to IR's 25KV RE and its effect on DFC equipment shall also be taken into account.

4.5.3 Above referred electromagnetic compatibility investigation shall be carried out referring IEC62236 but need not to be constrained by it.

4.5.4 The Contractor shall measure the signal level and noise level in the site especially near the substation. Both P-14 and P-7 contractors shall confirm the electromagnetic compatibility based on the measured data.

4.5.5 The Contractors shall submit the confirmation with data to the Engineer for review after the site testing.

4.6 Painting Requirements

4.6.1 All signalling gears shall be painted and numbered as per provisions given in Signal Engineering Manual.

4.6.2 Clearances of individual track side gears from nearest rail shall be painted on the gear itself. Sample for the same shall be got agreed by the Engineer.

* * * End of Chapter 4 * * *

5. FUNCTIONAL REQUIREMENTS

5.1 General

1) Signal (Home/Gate, Distant & Inner Distant signals) spacing in Block sections shall be about 2 Kms. 4 aspects Multi Aspect Colour Light signals shall be used on Main and running Lines. Signalling system shall be designed accordingly.

2) Signalling system shall mainly consist of Train detection system (TD), Electronic Interlocking (EI) system, Train Monitoring and Diagnostic system (TMS) and other systems.

3) The Signalling equipment shall immediately report certain functions, typically, but not limited to the following:

   a) Identification of failure of point throwing or detection;
   b) Identification of signal defects;
   c) Power supply failures including PSS defects and earth faults;
   d) Untimely or out-of-sequence operation of equipment;
   e) Passing Signal at Danger.

4) All alarms shall clearly indicate the nature and the location of the cause. ASMs and OCC staff shall have manual facilities to acknowledge (and thus cancel) each alarm individually.

5) The Signalling System shall enable a non-volatile log to be compiled of all ASM/controller actions, changes of state of indicators and points, transmissions, alarms, alarm cancellations, train progress, mode of operation and changes, Signal Passing At Danger (SPAD), opening and closing of SER, Porta Huts doors, PSS status changes, all relay status changes, ELD status, DAC status etc., during the previous 48 hours, all date and time stamped in accordance with the Master Clock.. If in built facility of individual sub systems is not adequate for this purpose, then external Data Logger shall be provided as per RDSO specification.

6) Portable Fire Extinguishers suitable for electronic equipment shall be provided by the Contractor in all S&T equipment rooms including Location Huts.

5.2 Equipment Response Time

1) Equipment response times for all OCC and SER equipment shall be inclusive of all processing time and display time.

2) Response time in this context is time taken for the equipment to process the commands (or input) and generate a signal at the output (MMI).

3) All commands initiated by ASMs/Controllers shall generate an immediate change in the display to indicate that the command has been received and this change shall be such that pending commands are distinguishable from completed commands so as not to induce any ambiguous recognition on the part of the ASMs/Controller and potential unsafe operation.

5.3 NOT USED.

5.4 Train Detection system

5.4.1 General

5.4.1.1 Train Detection system shall consist of Multi Section Digital Axle Counters which shall be as per RDSO specification.

5.4.1.2 Separate evaluators shall be provided for UP and DN lines.

5.4.1.3 Light vehicles like push trolleys, dip lorries, rail dollies etc. shall not be counted. This shall not require trolley suppression track circuits.

5.4.1.4 Train detection shall be provided on complete main line and station tracks except berthing portions of sidings at stations.

5.4.1.5 For Train detection system, the Contractor shall propose his own measures to enhance safety and reliability at all locations on the entire line.

5.4.1.6 The Contractor shall ensure proper provisioning of Earthing and Bonding arrangement so that it does not interfere with safe and smooth functioning of Train detection system.

5.4.1.7 Train detection system shall be vital and comply with the Clause 4.2.2.

5.4.1.8 Resetting arrangement of Axle Counters shall be followed as per latest instructions issued upto base date for use on Indian Railways.

5.4.1.9 The “error”, “occupied” and “unoccupied” states of axle counters shall be indicated to ASM/OCC staff. Also, if an additional state is provided for use during resetting, this shall be indicated to the ASM/OCC staff.

5.4.1.10 When the signalling system starts up after long duration power failure, all track sections shall show occupied until verified clear and reset by ASM.

5.4.1.11 Track devices on cross overs/points shall be provided considering Flank Protection and the least dead section.

5.4.1.12 Bonding Plan showing location of the Axle Counter Track Devices and proposed Traction Return Bonds and Cross bonds keeping required spacing from Axle Counter Track Devices shall be prepared and submitted for review by the Engineer. The length of cross-bonds shall be kept as short as possible.

5.5 Electronic Interlocking System

5.5.1 General

5.5.1.1 Electronic Interlocking (EI) system shall be computerized and fail safe.

5.5.1.2 Every station shall be provided with independent centralized EI system.

5.5.1.3 Any one of the following architecture shall be employed in the system

(a) Two out of three hardware architecture with identical hardware and identical or diverse software.

(b) Two sets of two out of two hardware architecture with identical hardware and identical or diverse software in hot standby mode. Failure of hardware will facilitate automatic change over in a fail safe manner without affecting train operation.

(c) Two sets of single hardware architecture with diverse software in hot standby mode. Failure of hardware will facilitate automatic change over in a fail safe manner without affecting train operation.

5.5.1.4 Object controllers (OC), if used, shall have similar architecture as of Central interlocking Unit (CIU). It shall work as slave unit of CIU through duplicated serial communication. The medium of communication between CIU and OCs shall be duplicated OFC rings. The details of OFC communication network are given in Particular Specification (PS) Telecom.

5.5.1.5 Multi Aspect Colour Light Signalling system will be provided using tubular signal poles and colour light signalling units as per RDSO specifications. Every main and running line stop signal (except Home & Advance Starter) at the stations shall be associated with shunt signal to deal with different operating scenarios.

5.5.1.6 Minimum 20% slots shall be kept as spare in EI for inserting cards for future expansion.

5.5.1.7 At least 20% cores shall be kept spare in every cable. All cores including spares shall be terminated.

5.5.1.8 EI processor shall have sufficient capacity to handle the expanded installation as per yard layouts supplied without any degradation in performance.

5.5.1.9 EI system shall be designed based on IRSEM, DFCCIL G&SR and RDSO Specifications.

5.5.1.10 EI system shall ensure following functions (but not limited to):

1) Route Locking after Route setting;
2) Route holding while train passes through the route set;
3) Approach Locking after Route cancellation when train approaches the set route (including Gate Signals) and
4) Detector Locking while the train is passing through on turnouts.
5) Facility to Block/Unblock any signal route or Track section.

5.5.1.11 EI system shall be independent from TD System and shall continue to work even when TD System has failed.

5.5.1.12 Contractor shall design the Signalling documents as per details given in Chapter 12 and submit to the Engineer for review based on the approved Track Layouts. Tentative Track Layouts are given in Volume V – Reference Drawings.

5.5.1.13 The typical signalling plans for Station and Block Section are in Volume V – Reference Drawings. The Contractor shall develop final signalling plans for all stations and Block signalling detailing all routes for the Engineer's approval.

5.5.1.14 Only LED type signals shall be used.

5.5.1.15 Some of the items requiring attention in respect of OHE installations, but not limited to, are as under:

1) Signals shall be mounted in locations where these are not hidden/ obstructed by OHE masts or other hardware and can be adequately sighted from the cab of a locomotive or maintenance vehicle at line speed and with adequate stopping distance. Signal visibility requirements as per SEM shall be followed.

2) Minimum safe distance between any signalling field installation and the live OHE contact point for the purpose of human safety apart from EMI/EMC considerations being as per SOD of DFCCIL for Western Corridor shall be ensured.

3) The staggering of OHE masts ahead of the signals shall be in accordance with ACTM.

4) Location of STOP signals shall be adjusted to ensure coasting of locomotives while negotiating neutral section.

5) The signalling system shall be designed so that no locomotive or a part of a locomotive stops within the neutral sections during normal operations.

5.5.1.16 For Big Yards, the Bidder shall be free to select the option between RDSO Specification RDSO/SPN/192 and RDSO/SPN/203 for Electronic Interlocking system.

5.5.1.17 Electric Point machines shall be installed at all turnouts. These shall be as per RDSO specification No. IRS: S 24. Following shall be ensured:

1) Points Motor:

Points motor shall work either on 380V 3 phase or 110V DC supply. The Contractor shall propose the type to be used. This shall be got agreed by the Engineer.

If the Bidder proposes 380V 3 phase supply for Points motor, then he shall submit Basic Specifications for the Points Motor which shall be developed into detailed specifications by the Contractor at Detailed Design Stage.

2) The Contractor shall ensure that:

(i) Points and Crossings are fit for interlocking as per provisions of IRPWM and Signal Engineering Manual;

(ii) the point machine installation and connection details are fully compatible with the design of the track work.

3) Where the points form a crossover, independent detection shall be provided for the points at each end of the crossover and separate detection shall be provided rather than super-imposed detection.

4) The Contractor shall provide all point motors, rods, detection, manual operated device and fixing facilities necessary to make the points into fully powered points suitable for Main Line operation with a capability for hand operation in emergency. The power shall be automatically cut off during hand operation.

5) Crank handle (interlocked) shall be provided for manual operation.

6) Loss of electrical power shall not cause a change of physical point status and the points and lock shall remain in the last operated position.

7) The Contractor shall provide suitable ramp covers in between the running rails from the outside of the curved switch rail to the toe of the points and crossings covering all associated points and crossing mechanisms, as well as the rods, to ensure that the maintenance personnel can walk safely over these areas.

5.5.1.18 Health and Condition monitoring of all equipment including point machines shall be provided.

5.5.1.19 Location of signals shall be determined by Signal Sighting Committee which shall be nominated by the Engineer.

5.5.1.20 All signals shall normally be fixed on left hand side of the track to which the signal pertains unless recommended otherwise by Signal Sighting Committee and approved by Competent Authority.

5.5.1.21 Where appropriate to the operating philosophy, signals at stations shall be provided with suitable route indicators.

5.5.1.22 Separation for UP and DN Lines:

i) Use of cables, I/O cards etc. shall be separate for UP and DN lines.

ii) Cables meant for UP and DN lines shall generally be laid in separate trenches outside respective DFCCIL tracks. In exceptional cases, when it is not possible to ensure the same, the Contractor shall suggest alternative method with detailed reasoning for consent by the Engineer and approval by the Employer.

iii) Location boxes meant for UP and DN lines shall generally be located separately outside respective DFCCIL tracks. In exceptional cases, when it is not possible to ensure the same, the Contractor shall suggest alternative method with detailed reasoning for consent by the Engineer and approval by the Employer.

5.5.1.23 As per para 15 of RDSO's Specifications of EI, following information is furnished:

S. No.	Item	Information
a)	Approved interlocking plan, selection table and panel diagram of the station (Cl. 3.1).	To be supplied by the Contractor.
b)	Whether CCIP (domino type) or VDU control terminal or both required (Cl. 5.1.4).	Only VDU.
c)	System output required to drive field gears – relay interface or object controllers.	Contractor to propose.
d)	110V AC or DC usage for signal lamp lighting.	110V AC.
e)	Size of VDU monitor screen, if ordered.	42" size.

5.5.1.24 To enable ASM to send commands to EI for route setting, operation of Points, Signals etc. at his station, latest Industrial grade embedded fan less terminal with 42" screen (1 screen for stations having upto 6 lines and 2 screens for stations having >6 lines) having resolution of 1920X1080 and to latest technology with equivalent standby shall be provided along with mouse and key board. For stations having >6 lines, yard display shall be suitably split between two 42" screens. Hardware configuration of the terminal shall be same as specified for Section Controller in Annexure 2.
For main/ standby to be used, a manual changeover switch accessible to ASM shall be provided so that he can changeover to standby terminal/monitor as and when required.

5.5.2 Signalling Principles

5.5.2.1 Route Locking and Setting

i) It shall be possible to set a route only when:

a) the route on which train is to traverse is proved clear not only up to next signal but also adequate distance beyond it;

b) any track sections on which another Vehicle can stand fouling the route to be set are proved clear;

c) All interlocked L.C. Gates in the route and overlap have been closed and locked;

d) the relevant points and crossings are free to move or are already lying in the correct position;

e) the route does not conflict with any other route that may have been set;

f) no block has been applied to any part of the route or its overlap section.

ii) Once a route is set, all the isolation points, points and crossings and interlocked L.C. Gates within the route and overlap shall remain locked in the position required for the route until the section of route is cleared or the route is cancelled and approach locking has been released.

iii) A train operated route release feature shall be provided on all routes.

iv) Route locking shall always be maintained ahead of a Train once it has entered a route, even if the route is subsequently cancelled. Once a route is cancelled, it shall progressively clear as a Train passes through it.

v) Signal approach locking shall be provided to ensure that once a proceed indication has been given, the set route shall be locked. Upon the request of a route cancellation, the approach locking shall release:

a) immediately provided that there is no Train in the designated approach Axle Counter Track sections;

b) after sufficient time elapses to ensure that an approaching Train has been brought to a standstill after occupying the designated approach track(s);

c) immediately after a Train has passed through the approach Axle Counter Track sections and entered the route.

vi) Route locking, route holding and all locking of signals as well as points and crossings shall not be affected if there is a transfer of control from any one control console to any other whether this second console is situated locally or remotely with respect to the first.

5.5.2.2 Point Setting and Locking

i) The setting of points and crossings shall only be possible when such settings do not conflict with other routes which have been set and the position and movement of Trains on the connected lines.

ii) The setting and locking of points and crossings shall be automatically completed once initiated by manual route request using entrance and exit principles. It shall be possible to set individual sets of points and crossings and in these circumstances such points and crossings shall only be permitted to move once they are free of any route locking, route holding, or track locking.

iii) Points shall remain in the last set position during and after transfer of control from any one control console to any other.

iv) Track occupied locking at points shall be provided.

v) It shall be possible to electrically lock an individual point against operation.

vi) Switch machine operating power shall be removed when a change in position is completed or after a pre-set time if position detection is not obtained. Points not detected shall not automatically motor back to their original position but shall remain in the position reached at the time the power is removed.

vii) In the event of a failure of a switch machine, it shall be possible to manually operate and secure points and crossings by authorized qualified staff at the trackside.

viii) During degraded or emergency operations, it shall also be possible to throw individual points and crossings. Under these circumstances, the points and crossings shall only be permitted to move once they are free of any route locking, route holding, or points blocking.

ix) Once points and crossings have been set, either by route or individually, they shall remain at that position until a new route or position is called.

x) The calling of points and crossings that are not available shall not be stored pending their release. Failure of a points call at the time of request shall result in an instant cancellation of the call.

xi) It shall be possible to operate the points both individually and through route setting.

xii) Trap points provided for isolation shall return to normal position after route release both under normal train running and route cancellation.

5.6 Stations

5.6.1 Interlocking system will presently be controlled from individual stations. However, provision shall be kept for provision of Centralized control from OCC in future.

5.6.2 Every Home signal shall be provided with Distant and Inner Distant signals located at about 2 kms. spacing from each.

5.6.3 Refer typical Signalling Plan for stations kept in Volume V of Bid documents.

5.6.4 Calling-ON signal shall be provided below Home signals.

5.6.5 Position light type Shunt signals shall be provided below all Starter and Intermediate starter signals.

5.6.6 Independent position light type shunt signals shall be provided for exit from sidings and shunt back from Advanced Starter signals and any other location considered necessary.

5.6.7 Buffer stops at terminal stations shall be provided with twin red signals fixed about one meter apart.

5.6.8 Non-trailable point machines shall be used.

5.6.9 Electric Point machines 220mm stroke shall be provided with external Clamp Lock.

5.6.10 42” (1 screen for stations having upto 6 lines and 2 screens for stations having >6 lines) VDU monitors with key board and mouse shall be provided in ASM’s office as operating panel for every station.

5.6.11 Cables from Home to Home signals in station areas will be laid in prefabricated RCC ducts having removable covers.

5.7 Block signalling

5.7.1 General

All the Block Sections in Dadri - Rewari section will be provided with Absolute Block Signalling. In addition, a total of 3 long Block Sections having inter station distance of more than 30Kms. will be provided with Intermediate Block signalling (IBS). Absolute Block Signalling shall use “Block Proving by Axle Counter using UFSBI” as per RDSO specification No. IRS:S 105.

5.7.2 Block Proving by Axle Counter (BPAC)

Some of the important features of the system are as follows:

i. The Block sections shall be provided with Block Proving by Axle Counter using UFSBI strictly in accordance with the RDSO specifications for Double Line and shall comprise of Block Panel, Universal Fail Safe Block Interface, DAC, Block Telephone, Relays etc.

ii. The functional requirements/specifications shall be read in conjunction with DFCCIL’s General Rules and its amendments issued thereon.

iii. The BPAC shall work on Optical Fibre Cable System.

iv. Power Supply requirement shall be met from PSS to be provided by the Contractor for S&T systems.

v. It shall not be possible to take the Last Stop Signal (i.e. Advance Starter) to "OFF" unless "LINE CLEAR" has been obtained from station in Advance.

vi. It shall not be possible to obtain "LINE CLEAR" unless Block section and Adequate Distance beyond the First Stop Signal (i.e. Home Signal) of station in Advance is clear of trains.

vii. The Last Stop Signal (i.e. Advance Starter) shall assume "ON" aspect automatically on entry of train into block section and when so replaced shall maintain its "ON" position till a fresh "LINE CLEAR" is obtained on Block Panel.

viii. Block section shall automatically show "TRAIN ON LINE" on panel when train enters into block section on Line Clear.

ix. Train Entry/Exit buzzer To/From block section shall be provided which shall be acknowledged by concerned ASM.

x. Block section shall automatically close on complete arrival of train at receiving station.

xi. A control mechanism shall be provided to prevent the station in rear to take "LINE CLEAR" on its Block Panel without taking consent of receiving station.

xii. A control mechanism shall be provided to "CANCEL" the "LINE CLEAR", already taken by station in rear.

xiii. It shall be possible to close the block section only if no train has entered the Block section for at least 120 seconds after application of Line Clear Cancellation with cooperation of station in rear.

xiv. Separate Block Telephones shall be provided for every block section.

xv. Separate evaluators shall be provided for UP and DN lines.

5.7.3 Intermediate Block Signalling (IBS)

IBS is an arrangement of Signalling in Double line to increase the sectional capacity. Its typical arrangement is shown in Drg. No. NKC-S&T-SSD-AL-10010 in Vol. V of Bid Documents. Its requirements are as under:

i. The following three long Block Sections shall be provided with Intermediate Block Signalling System.

   a. Dharuhera - Mewat
   b. Mewat - Pirthala
   c. Prithala – Faridabad

ii. Each Block Section shall be divided into two portions viz. Rear Section and Advance section.

iii. Axle Counter with dual detection and reset facility in cooperation with station in Advance shall be provided for each rear section.

iv. All indications and alarms pertaining to IBS shall be included in the display of the signalling system at stations at either end of the Block section.

v. BPAC shall be provided for each Block Section.

vi. The Loco Pilot shall be able to talk to station in rear from each IB signal. This requirement shall be met by GSM(R).

vii. Multi Aspect Colour Light IB Signal shall be provided to protect the Block Section ahead in a way similar to Advance Starter. The location of IB Signal should be somewhere in midway of the block section preceded by Distant and Inner Distant Signals. Spacing between IB Signal, Inner Distant Signal and Distant Signal shall be about 2 Kms. Each.

5.8 Level Crossing gates

All level crossing gates shall be interlocked with signals. Tentative list of gates is kept in Data Book Vol. IV of Bid Documents.

5.8.1 Every Gate stop signal shall be provided with Distant and Inner Distant signals located at about 2 kms. spacing from each.

5.8.2 The gates shall be manually operated by gateman.

5.8.3 Electric Lifting Barrier with Hand Generator working on 110V AC as per RDSO specification shall be provided at all the gates to be interlocked.

5.8.4 Gateman shall be provided with an indication cum control panel. This panel shall have required push buttons/switches for gate operation and also show status of approaching trains, Axle Counter Track sections (if provided) and signals for DFCCIL tracks.

In addition, indication for the 'ON' and 'OFF' aspects of gate signals (wherever provided), occupation/ clearance of the controlling track circuits upto the point of approach warning and direction of movement of the trains on the IR track(s) shall also be displayed on the panel.

5.8.5 Road signals, audio visual warning and other safety devices for road users shall be provided at Level Crossing gates as per Chapter XIV of IRSEM copy of which is kept at Annexure 5.

5.8.6 Normally a single set of common lifting barriers shall be provided outside the IR and DFCCIL tracks so as to protect both the IR as well as DFCCIL tracks by one set of booms. Wherever spacing between IR track and DFCCIL track is such that a road vehicle can stand there during passage of train(s), separate set of barriers shall be provided for IR and DFCCIL tracks.

5.9 Train Monitoring and Diagnostic System (TMS)

5.9.1 Train Monitoring and Diagnostic System (TMS) provided by P-5 Contractor shall be supplemented for Dadri – Rewari Section (Phase 2) by P-14 Contractor as per Functional Requirement Specification (FRS) and Technical Specification kept at Annexure 1 and Annexure 2 respectively duly coordinating as per details given in Annexure 7-3.

5.9.2 TMS system shall collect the necessary information for train operation from the signalling system located on the line with Backbone Transmission system. Backbone Transmission system is described in Telecommunication portion of the Bid document.

5.10 Power Supply System (PSS)

5.10.1 PSS shall cater to combined S&T equipment loads at stations and OCC.

5.10.2 PSS capacity at Crossing stations shall include future load with addition/ extension of loops to 1500m length as indicated in tentative Track Layout plans given in Vol. V of Bid documents.

5.10.3 In Block sections, independent PSS shall be provided for Signal and Telecom Porta huts.

5.10.4 Input power supply options shall be as under:

S. No.	Location	Available Supply	
		Voltage	Source
1.	Stations	230V, 50 HZ, 1 Phase	UP AT & DN AT
		415V, 50 HZ, 3 Phase	Local supply & DG set
2.	OCC	415V, 50 HZ, 3 Phase	Local supply & DG set
3.	Block sections	230V, 50 HZ, 1 Phase	UP AT & DN AT

5.10.5 240 V Single Phase AT supply tapped from both UP and DN OHE with Automatic Changeover as per standard arrangement of IR shall be provided in Power Supply Room of S&T at all stations and Porta Huts. Porta Huts located within 2 Kms. of each other shall be grouped together and fed from one set of such UP/DN AT supply.

5.10.6 Automatic selection arrangement between Local supply and DG set (wherever used for S&T) shall be provided.

5.10.7 AT supply shall be primary source for PSS due to its inherent better reliability.

5.10.8 (a) The Bidder shall submit proposal with Diagram and Basic Specifications indicating input power supply / supplies proposed for use as well as equipment provision downstream at stations and Block Sections separately. This should contain all necessary details to enable understanding of the proposal at Bid stage. This shall be developed into detailed Specifications by The Contractor at Detailed Design stage.

(b) For OCC, P-14 Contractor shall give his load requirements to P-5 Contractor for incorporating in design of PSS to be provided by him. However, P-14 Contractor shall submit details of equipment proposed for provision by him downstream of PSS.

5.10.9 PSS shall have inbuilt redundancy.

5.10.10 Power Supply system shall keep supplying power at full connected load at least for 4 hours during feeding power failure with at least 20% spare capacity.

5.10.11 Batteries provided with PSS shall consist of sealed maintenance free Valve Regulated Lead Acid (VRLA) cells as per RDSO specification No. IRS S:93(A). These shall generally consist of 2 Volt cells. However, Monoblock batteries in sizes of 6 or 12 Volts may be used in PSS of low capacity (e.g. in Block Sections) with the consent of the Engineer.

5.10.12 The Contractor shall be responsible for provision of all power supply requirements for the Signalling System downstream of the power feed including PSS.

5.10.13 All power supply equipment e.g. transformers, DC-DC converters, Chargers etc. shall have one standby equipment with changeover facility.

5.10.14 Modules used shall be hot swappable.

5.10.15 The design shall take into consideration the voltage drop between the power supply source and the Signal & Telecommunication systems load (as the case may be), individually at each location (porta cabin, station etc.).

5.10.16 Provision of suitable earth leakage detection and alarms shall be made individually at each location (porta cabin, station etc.).

5.10.17 **Provenness**

(a) The PSS vendor must have proven track record (PTR) of satisfactory performance of same model and rating of PSS Systems in any Metro Railway / Railway / Monorail for signal and telecommunication for at least five years. The Bidder shall submit installation details and User's contact details for verification of PTR.

(b) If requirements as per (a) above cannot be met, reasons for the same shall be submitted well in advance for review without objection by the Engineer. The PSS in such a case shall be required to undergo Type Tests as per Clause 9.6 of Vol. III Part 1 of ~~P-5~~ Bid documents.

5.10.18 The PSS shall be designed such that failure of or restoration of the 230V AC 1 phase / 415 V AC 3 phase input supply sources shall not have any change or effect and the PSS Inverters will continue to supply to the loads without interruption. Galvanic Isolations both at the Input as well as at the inverter Outputs shall ensure that at no point of time any part of the input supply is electrically connected to the PSS Output bus. Upon restoration of the Input Supply, the PSSs and Stabilizer shall be transferred to it only after a delay and verification that there are no spikes and that the voltage has stabilized.

5.10.19 At stations, two independent redundant primary power input feeder cables shall be provided from selected supply switch to inside the PSS/Battery Room by the S&T Contractor.

5.10.20 PSS ratings shall be subject to approval by the Engineer based on Load sizing calculations submitted by the Contractor during Detailed Design.

5.10.21 The battery racks shall have anti acid painting. The battery racks shall be properly insulated and earthed.

5.10.22 The battery shall be adequately designed to ensure minimum voltage drop in the battery system.

5.10.23 Battery sets shall be supplied only when the site is ready for commissioning of Signalling & PSS hardware is installed.

5.10.24 Spare Cell Charger for charging 1 to 6 Nos. of 2V cells or Monoblock batteries of 6 or 12 Volts at 10% of Battery AH Capacity shall be supplied as Spare at each station.

5.10.25 Following requirements for enclosures shall be met:

a) Minimum degree of protection to IEC 60529: IP31 – for Stations & OCC and IP42 for Porta Cabins.

b) Material and construction: Welded mild steel. Assemble to prevent distortion when the complete enclosure is lifted or transported.

c) Finish RAL7016.

d) Lockable access doors.

e) Cable entry with removable gland plates: For bottom entry cables.

f) Forced ventilation fans: Required.

g) Internal and External interlocking, padlocking, earthing, insulation, screening and enclosing.

h) Protection against natural corrosion and galvanic corrosion of dissimilar metals.

5.10.26 The PSS system shall be equipped with a status panel to provide monitoring and control of the complete system. Basically, the system shall be able to display the Alarms and Alerts on the System Front Panel LCD Screen upon their occurrence. If number of alarms generated is more than the display capacity of the screen, these will be displayed in the screen in continuous cyclic order.

5.10.27 A single or multiple LCD Panel Metering shall be provided with the capability of monitoring of the following system parameters using a selector switch:

a) Input voltage;

b) Input frequency;

c) output voltage (line-line);

d) output voltage (line-neutral);

e) output current (line);

f) output real power (line);

g) bypass frequency;

h) inverter frequency;

i) bypass voltage (line-line);

j) battery voltage;

k) battery current (charging/discharging);

l) output apparent power (line);

m) temperature (battery room) ;

n) % line load;

o) % battery charge.

5.10.28 A system mimic diagram using light emitting diodes (LEDs) shall be provided on the equipment as part of the system status panel. The mimic shall depict a complete single line diagram of the PSS and the following functions (but not limited to) shall be lit with LED indicators.

(a) A.C. input power on;
(b) PSS on battery;
(c) Inverter ON;
(d) Load supplied from Inverter.

5.10.29 Normally open and/or normally closed dry contacts shall be provided for the following minimal conditions :

(a) Low Battery (pre alarm);
(b) Load on Inverter.

5.10.30 Suitable connection shall be available from each PSS for local monitoring in the station, porta cabin etc. Required Cable will run from each PSS to a computer in the SER. Further, the Contractor will submit detailed list of Alarms/Parameters which will be locally monitored for consent by the Engineer.

5.10.31 The detailed status/alarms shall be available in the OCC and other terminals as per details given in TMS Technical Specification. Further, all necessary Software shall be provided and installed so as to see comprehensive data from all the Stations, Porta cabins etc.

5.10.32 Further, bidder will submit comprehensive remote monitoring philosophy in his technical bid.

5.10.33 Transient Voltage Surge Suppressor (TVSS) devices shall be provided at the inputs and output of the PSS to protect the PSS and the load equipment against any power surge due to lightning, switching, etc. Its basic Specifications shall be as under:

5.10.33.1 TVSS shall be provided at the Input of each PSS and electrically located at the respective outgoing feeders in the Input Transformer Cubicle. Further, TVSS shall be provided at each Outgoing Feeder of the PSS Output AC Distribution Panel. The ratings of the TVSS will be subject to approval.

5.10.33.2 The TVSS shall be constructed of Metal Oxide Varistor (MOV) technology and internal surge capacitors.

5.10.33.3 The surge protective devices shall be sized as per IEEE C62.41-1991 and IEEE C62.45-1992.

5.10.33.4 The TVSS shall have a UL1listing and labelled 1449-3 suppressed voltage rating of 800V peak.

5.10.33.5 The unit shall have a maximum continuous operating voltage (MCOV) rating of minimum 320V RMS.

5.10.33.6 The Response time of TVSS shall be <= 0.5 nanoseconds.

5.10.33.7 The TVSS shall provide up to 40dB for RFI & EMI noise attenuation.

5.10.33.8 TVSS monitoring shall consist of indicator lamps and form C dry contacts.

5.10.34 The Contractor shall:

i) sectionalise the power feeds to logical groups of equipment to allow for ease of maintenance and to enable maintenance to be carried out without disturbing the operation of all other equipment groups;

ii) run the power feed as a ring circuit to a number of trackside items of equipment in the same area. The design of the distribution shall ensure that a technician can isolate the power feed to an item of equipment, without affecting the operation of other equipment/items connected to the ring.

iii) electrically protect all individual electrical items of equipment by means of MCB. These shall be arranged to ensure that a short circuit fault on one item of equipment shall not affect the operation of other items of equipment;

iv) ensure that all items of electrical equipment are properly earthed and details shall be provided by the Contractor to demonstrate that protection is provided in the earthing concept;

v) provide individual earth leakage detection for all ac and dc power supplies for the safety of the maintenance personnel and provide a visual indication to indicate if an earth leakage trip has occurred. Earth leakage detectors provided shall work on the live/neutral current imbalance checking method and shall not depend upon any earth reference for correct operation, unless alternative arrangements are specifically approved by the Engineer. Where earth leakage detectors are not used, the design of the signalling power supply distribution system shall ensure that earth leakages or inter-core short circuits are detected and indicated through alarm;

vi) ensure that any failure of power supply equipment shall be recorded and indicated at the local control maintenance panel, local ASM, Signal Fault Controller and traffic control work stations and

vii) ensure that the design, installation and testing of the power distribution and earthing system are carried out in accordance with the requirements of IEC60364.

5.11 Bonding Design

5.11.1 The Contractor shall ensure that the design of Traction bonding shall not have any adverse effect on functioning of Axle Counters.

5.11.2 The Contractor shall submit details of all Axle Counter track devices and Traction Supply return bonding arrangements to the Engineer for approval.

5.12 Signage

5.12.1 The Contractor shall provide and install all railway operational signs which complement the Signalling system. These shall generally be located on trackside and shall be auto-reflective.

5.12.2 All signs shall be provided with appropriate symbols and in both Hindi and English text.

5.12.3 For example, the following signage shall be provided but not limited to:

a) Stopping limit sign board.

b) NOT USED.

5.12.4 The Contractor shall coordinate with the Engineer for the signalling signage to be provided to meet with the overall signage requirements.

* * * End of Chapter 5 * * *

6. SYSTEM REQUIREMENTS

Item	Requirement
1. Train Detection system	
1) Block sections	MSDAC shall be used for TD. The system status and alarms shall be connected to TMS on line.
2) Stations	MSDAC without redundancy shall be adopted.
2. Interlocking system	
1) Method	Computerized Interlocking system shall be adopted.
2) Redundancy	Duplicated or 2 out of 3 redundancy system shall be adopted.
3) System cycle	Cycle time and response time shall meet the requirements of Clause 5.1.2 of RDSO Spec of EI. Cycle time and response time of the system shall be clearly indicated.
4) Safety level	Safety level shall comply with SIL 4 as defined in para 4.2.
3. NOT USED	
4.TMS	
1) System type	It shall be computerized.
2) Redundancy	It shall be duplex system or equivalent.
3) External transmission	It shall adopt Optical Fibre Cable LAN.
4) Transmission speed	It shall be equal to or more than 100Mbps.
5) Train Graph kinds	These shall include following but not limited to: Current Graph; Future Graph.
6) Console type	It shall be Graphic User Interface with VDU or equivalent.
7) Mimic Panel type	It shall be Rear Projection Type.
5. Other systems/equipment	
5-1 Train Number system	
1) Method	ASM/TC will set the number. The setting shall not be changed by unintentional operation.
2) Train Number	It shall be upto 8 digit alphanumeric.
5-2 Signals	
1) Aspect	Four colour light aspects red, yellow, double yellow and green are required. These indicate as under: **Red**: Stop. **Yellow**: "Caution" i.e. Proceed and be prepared to stop at the next stop signal. **Double Yellow**: "Attention" i.e. Proceed and be prepared to pass next signal at such restricted speed as may be prescribed by special instructions. **Green:** Proceed Calling-ON signal shall be provided below Home signals.

Item	Requirement
1. Train Detection system	
1) Block sections	MSDAC shall be used for TD. The system status and alarms shall be connected to TMS on line.
2) Stations	MSDAC without redundancy shall be adopted.
2. Interlocking system	
1) Method	Computerized Interlocking system shall be adopted.
2) Redundancy	Duplicated or 2 out of 3 redundancy system shall be adopted.
3) System cycle	Cycle time and response time shall meet the requirements of Clause 5.1.2 of RDSO Spec of EI. Cycle time and response time of the system shall be clearly indicated.
4) Safety level	Safety level shall comply with SIL 4 as defined in para 4.2.
3. NOT USED	
	Position light type Shunt signals shall be provided below all Starter and Intermediate Starter signals. Independent position light type shunt signals shall be provided for exit from sidings and shunt back from Advanced Starter signals and any other location considered necessary.
2) Visibility distance	Main signal: minimum 600m. Shunt signal: minimum 200m.
3) Light type	These shall be LED.
5-4 Point machine	
1) Type	Non trailable
2) Switching time	It shall be less than 4 seconds.
3) Supply Voltage	To be proposed by the Bidder.
4) Environmental condition	Structure of the machine shall be as per RDSO specification.
5) Installation condition	It will be 60kg UIC/60E1 standard, Running Rail Fastening installation. Machines shall be installed on PSC (Pre-stressed Concrete) sleepers.
6) Locking	External Clamp Lock
7) Detection	It shall be as per RDSO specification.
5-5 NOT USED	
5-6 Power Supply System (PSS)	
1) Uninterrupted time	It shall be at least 4 hours.
2) Redundancy	Required.
3)PSS Input Supply voltage	Stations & OCC: AC 415V, 50Hz, 3 phase and/ or AC 230V, 50Hz, 1 phase. Intermediate Block Signalling: AC 230V, 50Hz, 1 phase.
4) PSS Output Supply voltage	To be proposed by the Bidder.

Item	Requirement
1. Train Detection system	
1) Block sections	MSDAC shall be used for TD. The system status and alarms shall be connected to TMS on line.
2) Stations	MSDAC without redundancy shall be adopted.
2. Interlocking system	
1) Method	Computerized Interlocking system shall be adopted.
2) Redundancy	Duplicated or 2 out of 3 redundancy system shall be adopted.
3) System cycle	Cycle time and response time shall meet the requirements of Clause 5.1.2 of RDSO Spec of EI. Cycle time and response time of the system shall be clearly indicated.
4) Safety level	Safety level shall comply with SIL 4 as defined in para 4.2.
3. NOT USED	
5-7 Earth Leakage Detector	
To be provided on	All power supplies used in Signalling system.

* * * End of Chapter 6 * * *

7. TECHNICAL REQUIREMENTS

7.1 Fail Safe Technology

7.1.1 The Contractor shall submit the fail safe principles adopted and supporting details about all the fail safe sub-systems.

7.1.2 Following sub-systems shall comply with the SIL 4 requirements as defined in para 4.2.

- Electronic Interlocking system
- Track Vacancy detection system.

7.2 Fool proof Technology

1) Following operations, but not limited to, shall be possible with fool proof mechanism like two stage critical command, latched key, simultaneous operation with more than two (02) switches or buttons or cooperated operation by two persons:

   - Route Cancellation.
   - Point machine Crank handle release.
   - Point operation under Axle Counter Track section failure.
   - Resetting of Axle Counter.
   - Relaxation or removal of Temporary Speed restriction.

2) The Contractor shall prepare and submit the list of such operations along with proposed method of fool proof mechanism for Engineer's review.

7.3 Communication Recovery Technology

The Contractor shall prepare and submit recovery method in connection with following systems for Engineer's review.

- Communication between OCC and station when the optical fibre cable is cut off or the node has failed and
- Communication between station and Porta Hut when the optical fibre cable is cut off or the node has failed.

7.4 Processing Time

1) The Contractor shall demonstrate performance of signalling system in terms of time elapsed between initiation of a command and completion of its execution confirmed on the operation cum control panel.

2) The Contractor shall attach the time chart with processing time of each sub-system in the most critical operation case at one of the Junction Stations (To be nominated by the Engineer) on design stage.

7.5 Ergonomic Technology

1) Systems with man-machine interface like ASM's console and mimic panel for TMS system shall be designed conducting human engineering. Especially colour for indication, switches and buttons layout for operation shall be designed with ergonomic technology.

2) Contractor shall state how ergonomic technology is conducted in the system.

7.6 Redundancy Technology

1) Following sub systems shall be provided with inbuilt redundancy:
   a) Electronic Interlocking;
   b) PSS.

2) The above sub systems shall be redundancy designed to work even if one equipment and/or component has failed. When one equipment and/or component fails, an alarm for failure shall be immediately raised to OCC, Signal fault Controller, concerned ASM etc.

3) NOT USED.

4) The Contractor shall show the redundancy method (duplex system, 2 out of 3 or multi-systems), whether hot-standby and reliability values of its system.

5) When system changing occurs because of one system failure, contractor shall confirm that the system changing shall not interrupt the working function.

* * * End of Chapter 7 * * *

8. CONTRACTOR'S COORDINATION WITH OTHERS (INTERFACE MANAGEMENT)

8.1. General

The Contractor (CT P-14 Contractor) shall interface with Other Contractors (Contractors of ST P-5, RS P-7, CT P-1 & 2 and CT P-15C packages), Interfacing parties, relevant authorities and agencies to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of Works. The interface described in this document is for reference of the Contractor. This list does not in any way relieve the Contractor and the interfacing contractors of their obligations to resolve the interface issues which may be called for.

8.2. Contractor's Responsibility

8.2.1. The Contractor shall ensure that all the interface items as listed in this Specification, shall be included in the Interface Management Plan.

8.2.2. Other items not mentioned in the interface items but being relevant to the design, installation, testing and commissioning of the Permanent Works shall also be included in the Interface Management Plan.

8.3. Physical Interface with Other Contractors, Interfacing Parties, relevant authorities and agencies

A number of interfaces identified during Outline Designs that shall require particular attention by the Other Contractors / Interfacing Parties, relevant authorities and agencies are given in appendices listed below:

(i)	Annexure	7-1	CT P-14 /RS P-7 (Specific Issues)
(ii)	Annexure	7-2	CT P-14 /Indian Railways (Specific Issues)
(iii)	Annexure	7-3	CT P-14/ST P-5 and To Be Decided (TBD) Contractor (Specific Issues)

8.4. General Definitions and Scope

8.4.1. This covers the interface requirements between the Contractor and Other Contractors/ Interfacing Parties, relevant authorities and agencies.

8.4.2. This is common to all the interfacing contracts.

8.4.3. This document shall be read in conjunction with the relevant paragraphs of the General Specification – Vol. II Part C. The Contractors (the Contractor and Other Contractors) shall ensure that all requirements of the General Specification – Vol. II Part C and Particular Specification pertaining to interfaces are fully resolved and implemented.

8.4.4. In the event of a conflict between the Particular Specification and the Appendices as listed above, the Contractor shall always immediately seek advice from the Engineer.

8.4.5. "Project Wide" for the purpose of the Appendices is defined as the complete Scope of Work to be executed under Contracts CT P-14, RS P-7 and CT P-15C including other obligations of the Employer for successful commissioning of Rewari – Dadri section of DFC Western Corridor Phase 2.

8.4.6. The "Project Wide" scope for the Contractor and Other Contractors shall include both internal and external interfaces including but not limited to Indian Railways and other Utility Agencies.

8.4.7. The term "Third Parties" for the purposes of this document means all affected infrastructure owners, whose equipment is directly or indirectly affected by the Project Wide Scope of Works. This shall include Indian Railways, telecom operators, water and gas pipe line owners, emergency services, hospitals etc.

8.5. Contractors' Responsibilities

8.5.1 This para outlines the Contractor's interface requirements which are based on the Technical Studies carried out during the early stages of the Project (DFC Western Corridor Phase 2). However, the requirements herein specified are by no means exhaustive and it remains the Contractor's responsibility to develop, update an "Interface Management Plan" and it shall be the responsibility of the respective Other Contractors to execute the same jointly during currency of their respective Contracts, to ensure that:

1) All interface issues between the Contracts are satisfactorily resolved;
2) Supply, installation testing & commissioning, operation and maintenance of Plant & equipment are fully co-ordinated;
3) All Plant & equipment and facilities supplied under the contracts are fully compatible with each other, whilst meeting the requirements of the respective specifications.

8.5.2 The Contractors (the Contractor and Other Contractors) shall jointly prepare an Interface Management Plan for exchange of information to achieve the interface requirements at an early stage in the Project, a copy of which shall be submitted to the Engineer for his consent and approval by the Employer.

8.6. Physical interface issues – General

8.6.1 Contractors' Responsibilities

8.6.1.1 CT P-14 Contractor shall be responsible for the preparation of the Project Wide Management Plans for electromagnetic compatibility, earthing & bonding and systems integration. All the Contractors shall be responsible for implementing the requirements of the Project Wide Management Plans.

8.6.1.2 CT P-14 Contractor shall act as system integrator for a number of critical interfaces between the design, construction, testing and commissioning of the Western Dedicated Freight Corridor covering the project wide scope of work.

8.6.1.3 This is required to ensure that Western Dedicated Freight Corridor is fully integrated for operation and safety.

8.6.1.4 CT P-14 Contractor shall provide Project Wide coordination for the following critical interfaces:-

1) Electromagnetic Compatibility (EMC) & Electromagnetic Interference (EMI);
2) Earthing & Bonding (E&B);
3) Systems Integration;
4) Integration Testing and Commissioning.

8.6.1.5 Each of the Contractors shall appoint a Dedicated Coordination Team led by an Interface Coordinator reporting to the respective Project Wide Contractor's Representative to perform the roles to undertake coordination of the Scope of Work within their respective contracts in regard to:-

1) Earthing & Bonding;
2) Electromagnetic Compatibility & Electromagnetic Interference;
3) Systems Integration.

8.6.1.6 Interface Coordinator of each of the Contractors shall be responsible for coordination of Electromagnetic Compatibility & Electromagnetic Interference, earthing & bonding and systems integration across the whole Project.

8.6.1.7 All the Contractors shall fully cooperate with such Interface Coordinators identified above. Should there be any disagreement between contractors and the relevant Interface Coordinators, then the

matter shall be referred to the Engineer for resolution of the issue. In case of any dispute between the Contractors with regard to Interface requirements, the matter shall be referred to the Employer for arbitration. The Employer's decision shall be final and binding on all the Contractors.

8.7. ELECTRICAL & PHYSICAL INTERFACE

8.7.1 Electromagnetic Compatibility (EMC) & Electromagnetic Interference (EMI)

8.7.1.1 The Project Wide EMC/EMI Management Plan shall fully detail the approach and processes to manage EMC across all the Works required for Design, Construction, Testing, Commissioning, Operation and Maintenance of the Project. It shall cover internal EMC interfaces within the Contractor's Scope of Work, EMC between other contracts and EMC interfaces between the Project and third parties. Preparation of the Project Wide EMC Management Plan shall be coordinated by CT P-14 Contractor in association with the Other Contractors and shall be submitted to the Engineer for his consent and approval of the Employer including its each revision (if any).

8.7.1.2 All the Contractors shall work to and comply with the requirements of finalized Project Wide EMC/EMI Management Plan as consented by the Engineer and approved by the Employer.

8.7.1.3 All the Contractors shall prepare EMC control plans that contain all the information that is required by the approved Project Wide EMC Management Plan for the Project. EMC control plans shall be submitted to the Engineer for his consent.

8.7.1.4 All the Contractors shall undertake EMC compatibility studies as required by the Project Wide EMC Management Plan. These studies shall identify all EMC risks and hazards with the respective Contractor's Scope of Work and any impacts on adjacent IR route including any other third party. Where joint studies are required with IR & third parties, these shall be facilitated by the Employer. Any changes to the Project Wide EMC Management Plan, if required to as a result of EMC compatibility studies and as approved by the Engineer / Employer, shall be coordinated by CT P-14 Contractor.

8.8.Earthing & Bonding

8.8.1 CT P-14 Contractor shall prepare a Project Wide Earthing & Bonding Management Plan in consultation with the Other Contractors, which shall fully detail the approach and processes to manage earthing & bonding across all works required to design, construct, commission, test, operate and maintain the Western Dedicated Freight Corridor. This document shall be submitted to the Engineer for his consent and approval by the Employer including its each revision.

8.8.2 All the Contractors shall work to and comply with the latest revision of the Project Wide Earthing & Bonding Management Plan.

8.8.3 All the Contractors shall prepare Earthing & Bonding Strategies and designs based on the requirements of the Project Wide Earthing & Bonding

Management Plan. These shall be submitted to the Engineer for his consent. The finalized Earthing & Bonding Strategies and designs shall be submitted to Interface Co-ordinator of CT P-14 Contract as per the agreed programme.

8.8.4 The Interface Coordinator of CT P-14 Contract shall chair Earthing & Bonding integration meetings to resolve earthing & bonding issues between the Contractor and Other Contractors and third parties. All contractors shall then revise their Earthing & Bonding strategies and designs accordingly, if required. Any issues that are not resolved shall be notified to the Engineer for resolution. In case of any dispute, the matter shall be referred to the Employer for arbitration. The Employer's decision shall then be final and binding on all the Contractors.

8.8.5 The Interface Coordinator of CT P-14 Contract shall integrate all of the Contractors Earthing & Bonding strategies into a single Project Wide Earthing and Bonding Strategy that shall be mandated across the whole Project and which all the Contractors shall fully comply.

8.9. ANTI THEFT CHARGING OF OHE

8.9.1 As an anti-theft measure, the OHE after erection may be charged at 2.2 kV by CT P-14 Contractor. However, before such anti-theft charging, which shall require certain precautions and safety measures to be taken by personnel of all the Contractors and of employees of adjacent railway system, the following precautions need to be followed. The precautions shall include but not limited to:-

- Issue of public notice in local newspapers for information to public;
- Notice to adjacent Indian railway administration;
- Procedure providing for issue and cancellation or permit to work on or in vicinity (within two meters of the live conductors & 25 KV equipment) to all concerned through and to authorized personnel as a requirement before the lines can be charged as an antitheft measure;
- 24 hour monitoring of the section and its patrolling;
- Permission of E.I.G.;
- DOT (Department Of Telecom) clearance.

8.9.2 CT P-14 Contractor shall give notice to the Other Contractors in this regard. The Other Contractors shall take necessary precautions while carrying out the Works keeping in view the anti-theft charging of OHE.

8.9.3 This antitheft charging shall not be done until no objection is received from the Engineer and Employer and confirmation received from him that Engineer's & Employer's staff have been warned of the hazards of adjacent line of DFC being charged and have been trained on the precautions required to be taken by them.

8.9.4 Detailed procedures and rules shall be prepared by the Contractor and submitted to the Engineer for his consent & issue to all the concerned.

8.10. Systems Integration Requirements

8.10.1 CT P-14 Contractor shall prepare a Project Wide Systems Integration Management Plan. The Project Wide Systems Integration Management Plan shall fully detail the approach and processes to manage systems integration across all the Works required to design, construct, commission, test, operate and maintain the Project.

8.10.2 The Systems Integration Management Plan shall cover internal systems integration within the Contractor's Scope of Work, systems integration between the other contracts and systems integration interfaces between the Project and third parties including Indian Railways. This document shall be submitted to the Engineer for his consent and Employer for approval including its each revision, if any. All the Contractors shall work to and comply with the latest revision of this plan and shall prepare a system integration strategy which shall be submitted to the Engineer for his consent. The system integration strategy, as consented by the Engineer, shall be forwarded to the Interface Coordinator of CT P-14 Contract.

8.10.3 CT P-14 Contractor shall integrate all the Contractor's system integration strategies into a single document with all interfaces agreed.

8.10.4 Prior to commissioning of any system, the CT P-14 Contractor shall prepare an Integrated Test Plan, detailing of tests to be undertaken to verify the functionality of the systems he is responsible for and to ensure that there are no adverse effects on Other Contractors or third party Works. Integrated Test Plan shall be submitted to the Engineer for his consent and approval by the Employer.

8.10.5 All the Contractors shall prepare Systems Integrated Testing Plan and submit the same to the Engineer for his consent and approval of the Employer. The Interface Coordinator of CT P-14 Contractor shall combine all Contractor's and third party Systems Integration Testing Plans into a single test plan. The plan shall cover as a minimum:-

a) Systems and sub systems to be tested;

b) Tests to be performed;

c) Requirements from Other Contractors (e.g. Locomotives or systems to be provided with instruments to obtain data from other Contractor's systems);

d) Test equipment to be used;

e) Programme of earthing and bonding;

f) Safety requirements for the test (e.g. suspension of service on Indian Railways or no staff other than test engineers on site);

g) Test pass/ fail criteria.

8.10.6 All the Contractors shall provide, generate or supply reasonable test data to each other; as identified in the Project Wide Systems integrated Test Plan.

8.10.7 The CT P-14 Contractor shall prepare a joint Test Report duly signed by him and Other Contractors within 2 weeks of the test being performed and submit it to the Engineer.

8.10.8 The Contractors shall immediately notify the Engineer and Interface Coordination Manager of CT P-14 Contract of test failures, if any.

8.10.9 Any modification to the Contractor's or any of the Other Contractor's equipment, if required, to rectify the integration issues shall be undertaken by the respective contractor(s). Any modification requirements to third party infrastructure shall be notified to the Engineer for completion of work by the third party which shall be coordinated by the Employer.

8.10.10 The final integrated test reports shall be used to substantiate the case for safe operation of the Project.

8.10.11 The test report, test measurement data and test plans shall form part of the As Built / As Erected records.

* * * End of Chapter 8 * * *

9. TESTING, COMMISSIONING AND VERIFICATION

9.1 General

(1) The Contractor shall provide and perform all types of tests applicable to the Works.

(2) All materials, goods, equipment and manufacturing processes for the Works shall be subjected to inspection and the witnessing of tests by the Engineer unless otherwise agreed in writing by the Engineer.

(3) The Engineer and/or any of their staff shall have the facility to monitor all tests and have access to all test records. Sufficient time shall be allowed within the testing programmes for necessary alternations to equipment, systems and designs to be undertaken, together with re-testing prior to final commissioning.

(4) Tests to be conducted by the Contractor shall be carried out in accordance with the requirements of the Contract.

(5) The inspections and tests shall be divided into following basic stages;

(i) Type test;
(ii) Routine tests carried out before offering for FAT;
(iii) Factory Acceptance Tests (FAT) carried out before delivery of equipment;
(iv) Site acceptance and integrated test;
(v) Trial runs.

(6) The inspection and passing of work or equipment by the 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.

9.2 Test Plan and Procedures

(1) All test plans and procedures shall be submitted for the review of the Engineer at least 30 days prior to conduction of any test together with the exact time and date of such test. Test procedures shall show the following unambiguously but not limited to:

a) date on which the Contractor proposes to conduct each of these listed tests;
b) nature and purpose of test;
c) extent of testing covered by each submission;
d) method of testing and test requirements with the relevant standards;
e) relevant drawing and document (or modification) status;
f) location of testing;
g) test parameters to be measured with the relevant standards;
h) constraints to be applied during the test with the relevant standards;
i) defined pass/fail criteria with relevant standards;

j) format of the raw data for processing by the Contractor;

k) test instrumentation and test circuitry to be used during the test with the relevant standards.

(2) Test procedures may be amended during the duration of the Contract to reflect changes in design or the identification of additional testing requirements.

9.3 Costs of Tests

(1) (a) All costs associated with provision of test facilities including test materials, test equipment, meters, instruments, raw materials etc. to enable carrying out of testing shall be borne by the Contractor.

(b) Testing charges payable to RDSO or any other agency engaged by the Employer for this purpose shall be borne by the Employer.

(c) Expenses of Travel, Hotel and Daily Allowance of the Employer/Engineer for inspection or witness (except cases mentioned in item (2) below) shall be borne by the Employer.

(2) If an agreed test is not acceptable as proposed due to absence of approved Test plan and procedures and/or Reports, failure to fulfil the pass criteria, lack of preparation, negligence or material and/or equipment being presented in a state which is clearly not acceptable, all costs incurred by the Employer or Engineer for repeated inspection and/or witness shall be borne by the Contractor.

9.4 Records of Tests

(1) Within fourteen (14) days after completion of any test, all necessary information regarding the test shall be submitted in a report for the Engineer's review. If required by the Engineer, a manuscript copy of the test record shall be made at the time of the test and given to the Engineer or at the earliest opportunity if the test has not been witnessed. On completion of each test or group of tests, the Contractor shall provide a signed and stamped test report containing following details:

a) number and types of tests which are required by the Specification and the results to be achieved;

b) tests actually carried out and the results actually achieved; and

c) confirmation of pass/failure accompanied with, if necessary, a schedule of further tests or actions to be carried out by the Contractor to achieve compliance with the Specification and the approved design.

(2) In addition to any other requirements, the report and its supporting documentation for the tests done by the Contractor for the Engineer's inspection and audit, shall contain the following details:

a) equipment, system, facilities or part of the Works tested;

b) location and size of the batch from which the samples were taken or the

location of the part of the Works;

c) reference to test procedures and test schedule;

d) place of testing;

e) date and time of tests;

f) weather conditions in the case of in-situ tests;

g) Names & designations of the technical personnel supervising or carrying out the tests;

h) size and description of samples;

i) method of sampling;

j) properties tested;

k) readings and measurements taken during the tests;

l) test results, including any calculations and graphs;

m) specified acceptance criteria;

n) List of measuring instruments used along with its Serial No., Make, name of authorised lab where last calibration was carried out and date up to which its calibration is valid;

o) other details required by the Contract.

9.5 Sources of equipment supply

(1) Equipment procured locally shall be from Part-I list of RDSO's "Approved list of firms for manufacture and supply" and as per relevant specifications. If any equipment proposed to be procured is from Part-II list, then the Contractor shall submit reasons for the same to the Engineer for getting his "No Objection".

(2) If any equipment proposed to be imported has RDSO specifications (IRS or SPN) and is not yet having Cross Acceptance approval (by RDSO/ DFCCIL), the concerned firm shall be got approved for the said equipment as per "Cross Acceptance" procedure of RDSO/ DFCCIL before commencement of Integrated Testing.

(3) If any equipment other than covered in item 9.5(1) and 9.5(2) above is proposed to be supplied, then the same must be proven being in regular use for at least last 2 years (except PSS for which provenness of at least 5 years as per Clause 5.10.17 shall apply). Details of the same shall be submitted well in advance for review without objection by the Engineer.

9.6 Type Tests

(1) If the Contractor proposes to supply any equipment not approved as per para

9.5 (1) & (2) above, the Contractor shall undertake the type testing of pre-production units to the satisfaction of the Engineer. The Contractor shall identify in its design submissions any equipment in this category.

(2) 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. These may be omitted where the Contractor is able to produce documentation from previous test that meets the requirements of the Engineer.

(3) 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. In this case, the Test Program shall foresee a combined schedule of Type Tests and corresponding Routine Tests of individual units.

(4) Type tests on equipment for which RDSO specifications exist, shall be as per relevant RDSO specification.

(5) 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.

9.7 Types of tests

9.7.1 General

(1) All equipment, materials and software shall be tested during manufacture and before delivery.

(2) Following types of tests are required to be conducted (but not limited to):

a) Routine tests;
b) Environmental (EMC/EMI) tests;
c) Interface protocol tests;
d) Software tests;
e) Factory Acceptance Tests (FAT);
f) Site acceptance and integrated tests
g) Trial runs.

9.7.2 Routine tests

(1) Routine tests shall be conducted on all equipment during the process of manufacture. The routine tests shall include:

a) Visual inspection

Visual inspections shall be carried out to ensure that the equipment is of sound construction and meets the requirements.

b) Diagnostic tests

Hardware diagnostic tests shall be carried out on each element of the

system including all workstations, computers, computer peripherals, devices.

c) Performance tests

Performance tests shall consist of a comprehensive series of measurements on the characteristics of the individual equipment to check if its performance is complying with the performance and functional requirements of the particular equipment concerned.

d) Soak tests

Equipment shall be set up in a manner to simulate normal operating conditions, switched on and allowed continuous operation for a minimum period of 100 hours. This period may be broken down into shorter period if compatible with the function of the equipment.

(2) Routine test reports shall be submitted to the Engineer before inviting him for FAT.

9.7.3 Environmental (EMC/EMI) tests

(1) All equipment supplied shall be tested in accordance to the EMC requirements defined in IEC 62236 Series : Railway applications – Electromagnetic Compatibility or relevant standard.

(2) All supplied equipment shall be tested for full operational ability under the conceivable environmental conditions.

(3) Environmental tests may not be required if previous independent witnessed tests have been successfully carried out and reported by document.

(4) If any failure occurs during the environmental tests or the equipment design is changed, it shall be reported to the Engineer who may at his discretion require repetition of the tests.

(5) Proximity of IR's 25KV RE lines shall be taken into account while determining prevalent environment for such tests.

9.7.4 Interface Protocol Tests

(1) Interface Protocol tests are required for the following, but not limited to, software interfaces:

a) Interface between Central Server and Traffic Controller's Console.

b) Interface between Central Server and ASM's Console.

c) Interface between Central Server and Signal Maintenance Consoles.

(2) Actual equipment shall be used for these interface protocol tests. Protocol simulators are not allowed.

9.7.5 **Software Tests**

The Contractor shall carry out the software proofing tests based on the Employer's requirement, but not limited to the following:

a) Database mapping tests for each station and Block section;

b) point-to-point tests;

c) functional tests;

d) performance tests.

9.7.6 **Factory Acceptance Tests**

(1) Factory Acceptance Tests of materials and equipment procured locally and having RDSO specifications (IRS or SPN) or appearing in RDSO's list of Approved Vendors shall be got done by RDSO.

(2) All equipment, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subjected to factory acceptance test. Notification of these tests shall be submitted to the Engineer 30 days in advance of carrying out any test together with information on any previous testing which relates to the items being tested. The Engineer will then determine to witness such test or which, if any, items may be accepted based on previous supply or experience.

(3) Factory Acceptance Tests shall include but not limited to:

a) physical inspection;

b) dimension check;

c) electrical check;

d) calibration;

e) output check;

f) operational performance including full functional software testing;

g) Insulation test;

h) soak test.

9.7.7 **Site Acceptance Tests and Integrated Tests**

(1) The site acceptance and Integrated tests shall be carried out on site after installation, which shall demonstrate that system and software meets the Employer's requirements in terms of functionality and performance.

(2) Site acceptance and Integrated tests shall include but not be limited to the following categories of tests:

a) Site acceptance tests:

The tests shall ensure that all the equipment supplied under this Contract satisfy the functional and performance requirements of the Employer's requirements when operated in a standalone manner without any interface to equipment/system supplied by other Contractors.

b) Integrated tests with other contractors:

The tests shall ensure that all the interfaces with other Contractors satisfy the functional and performance requirements of the interface

requirements.

c) Total system integration tests:

Having completed the integrated tests with respective Contractors individually, total system integration test shall be performed to demonstrate that all system modules can co-ordinate their works with each other in harmony and that all functional and performance requirements are satisfied. No crash or abnormality shall result from having various combinations of possible operations being carried out simultaneously.

(3) The scope of the site acceptance and integrated tests shall cover but not be limited to the following:

a) Visual inspection to ensure the equipment is installed properly in accordance with the installation submissions;

b) Electrical tests to ensure that the electrical connections of the cables, power modules, electronic modules, etc. are correct;

c) Operational performance including full functional software testing;

d) Communication tests between data transmission equipment;

e) Functional tests on all the control requirements;

f) Point-to-Point tests to ensure correct mapping between the database and the physical equipment I/O points. Failed I/O points to be listed to show that routing is still functioning;

g) End-to-End tests to ensure that all the connected plant can be controlled and/or monitored.

9.7.8 **NOT USED.**

9.7.9 **Trial Runs**

Trial Runs may be referred to in General Specification – Vol. II Part C.

* * * End of Chapter 9 * * *

10. INSTALLATION

10.1 General

10.1.1 The Contractor shall supervise all installation of the Works and shall ensure that all technical, safety and quality matters adhere to the Design as reviewed by the Engineer.

10.1.2 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.

10.1.3 The Contractor shall provide all necessary and sufficient resources such as tools, test instruments, spares, equipment, manpower and communication facilities to complete all the installation activities.

10.1.4 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.

10.1.5 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.

10.1.6 The Contractor shall submit installation method statements for each type of installation activities at least three months before the commencement of the activity to the Engineer for review.

10.1.7 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.

10.1.8 All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Engineer.

10.1.9 The Contractor shall assign competent site supervisors for each work site to be responsible for all site related matters.

10.1.10 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.

10.2 Installation Programme

10.2.1 The Contractor shall submit an Installation Programme for review by the Engineer.

10.2.2 The Contractor shall co-ordinate with relevant Project Contractors to agree with the date of access to the physical areas to carry out installation activities.

10.2.3 The Contractor shall develop the Installation Programme and take the following into account:

(1) Installation schedule;

(2) Key Dates and Milestones;

(3) site access;

(4) interfacing with relevant Project Contractors.

10.2.4 The Contractor shall highlight in his Installation Programme the resources and supports, if any, to be provided by the Engineer with dates, duration and locations.

10.2.5 The Contractor shall also highlight all relevant constraints, which may affect the Installation Programme, to the Engineer's attention.

10.2.6 The Contractor shall include dependencies between relevant activities in the Installation Programme.

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

10.2.8 The Contractor shall propose contingency plan to ensure that all the major Key Dates and Milestones can be met in case there is slippage in the installation activities.

10.2.9 Any subsequent changes in the reviewed Installation Programme shall be submitted to the Engineer for review.

10.3 Installation Works

10.3.1 Installation in Equipment Rooms

10.3.1.1 The following equipment rooms will be provided by the Contractor to install the Signalling equipment:

(1) Signalling Equipment Room (SER) at stations;

(2) S&T Power Supply Room;

(3) Gate Lodge.

10.3.1.2 Signalling Equipment Room (SER) is reserved for the installation of the signalling equipment, which is local to each station and its adjacent track sections. The SER will be equipped with air conditioning systems, lighting and power outlets. S&T Power Supply/Battery Rooms at the stations shall be provided with ventilation by the Contractor.

10.3.1.3 All items of local signalling equipment comprising active electrical and electronic components shall be located to the maximum extent possible in the SER and not on the trackside.

10.3.1.4 Electric power to the S&T Power supply room shall be drawn from selection of the power supply switch which will be provided by the Contractor.

10.3.1.5 For exact room dimensions, the Contractor shall however co-ordinate and refer to the final station building plans.

10.3.1.6 The Contractor shall liaise with the Engineer and relevant Project Contractors for access to the equipment rooms for installation.

10.3.1.7 All floor mounted equipment cabinets at the equipment room shall be securely bolted to ground, properly aligned and levelled.

10.3.1.8 All wall-mounted equipment shall be installed at appropriate height to avoid any hazards to the person passing by. The Contractor shall ensure the fixture is of sufficient strength to hold the wall-mounted equipment in a secure and safe manner.

10.3.1.9 The floor mounted equipment cabinets shall be arranged in the way to allow sufficient space at the front and rear side of the cabinets for maintenance access. Sufficient space shall also be allowed for front maintenance access of the wall mounted equipment.

10.3.1.10 The equipment layout within the equipment room shall be designed to allow sufficient clearance for escape out of the equipment rooms in case of emergency.

10.3.1.11 The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the installation inside the equipment room:

(1) drawings showing the equipment layouts and positions of the racks, cabinets and enclosures;

(2) racks, cabinets layout drawings showing the arrangement of individual module;

(3) specifications, sample of all the mounting brackets and accessories;

(4) equipment mounting and installation methods;

(5) schematic diagrams and wiring diagrams of the System;

(6) electrical distribution schematics within the room including the earthing details;

(7) cable route diagrams for cables within the room.

10.3.1.12 Installation work inside the room shall be carried only after these submissions have been reviewed without objection by the Engineer.

10.3.2 Outdoor Installation

10.3.2.1 All the ducts/ troughs for laying cables will be provided by the Contractor.

10.3.2.2 All the mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes and of sufficient strength to mount the equipment securely.

10.3.2.3 The Contractor shall submit the following to the Engineer for review at least three months before the commencement of the installation activities:

(1) specifications, sample of all the mounting brackets and accessories;

(2) equipment mounting and installation methods;

(3) schematic diagrams and wiring diagrams of the System.

10.3.2.4 If the equipment is installed at locations exposed to direct sunlight, the equipment, mounting brackets, cables and accessories shall be made of materials which are resistant to ultra violet rays.

10.3.2.5 All trackside equipment and the mounting method shall be designed in a way to minimize the frequency of preventive maintenance.

10.4 Cabling

10.4.1 RDSO's Guidelines on Signalling Cable Laying kept as Annexure 9 shall be followed in general. Any deviation to the same shall require prior approval of the Engineer.

10.4.2 Quad cable used shall be Jelly filled type.

10.4.3 Cables and wires used in OCC and ASM office equipment shall be FRLS type.

10.4.4 All cable routes shall be carefully coordinated with those of other system Contractors whether provided by the Contractor or third parties and when passing through Station areas.

10.4.5 All cables in OCC being provided in false floor shall be neatly secured on cable channels.

10.4.6 Primary cable containment in station areas and along track-side will be provided. DWC HDPE pipes shall be provided for required track, platform and road crossings.

10.4.7 Cable containment on steel girder bridges shall be provided as per guidelines contained in para 10.4.1 above.

10.4.8 The Contractor shall provide all necessary secondary cable containment and supports in addition to the primary cable containment provided to complete the connection to the Contractor's equipment.

10.4.9 All cables shall be neatly run and fitted in ducts or conduits, laid in trunkings, formed trenches or troughs, or supported by trays, hangers or cleats as appropriate.

10.4.10 Before commencing work on any part of the Site, the Contractor shall ascertain that the Engineer and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed each cable route without objection. The Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served.

10.4.11 The Contractor shall provide brackets and clips to secure all the cables at an adequate interval. Where cables are to be laid in troughs, the Contractor shall remove and re-instate trough covers prior to and after cable installation.

10.4.12 A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable

trays, ducts and trenches and at appropriate locations where necessary. Labels shall be provided at about every 100m spacing in complete length of every cable. Type of labels to be used shall be got approved by Engineer.

10.4.13 Cable drums shall always be mounted on jack and rotated for uncoiling and paying out of cable. Cable shall not be pulled for this purpose.

10.4.14 Cable drum shall never be kept on its side and cable uncoiled. Since this can result in twisting of cable conductors resulting in damage to them, any such instance noticed will result in the following liabilities on the Contractor:

(a) Remove such laid cable and cut into pieces of scrap of about 2 metres each;

(b) Lay new cable in lieu.

10.4.15 The installation and handling of cables shall be undertaken at all times by adequate staff suitably trained and supplied with all necessary plant, equipment and tools. The arrangement of the cables and all methods of laying shall be planned to provide an orderly formation, free from unnecessary bends and crossings. Following principles for laying of cables shall be adopted during track crossings:

(1) The cable crosses the track at right angle.

(2) The cable does not cross the track under points and crossings.

(3) The cable is laid in DWC HDPE pipes while crossing the track.

10.4.16 At culverts, the cables shall be suitably supported and protected with DWC HDPE pipes.

10.4.17 All cables shall be laid within the WDFC boundary. If it is necessary to lay the cable outside the WDFC boundary, permission shall be obtained before starting the trenching.

10.4.18 Digging of trench between IR track and WDFC track shall be manual or mechanized depending on availability of ROW. This shall be got agreed by the Engineer for every station/ Block section separately.

10.4.19 Cables in any conduits, trunkings or ducts shall not occupy cross-sectional space in excess of 50%.

10.4.20 At no location shall the cable be bent with a radius lower than the minimum radius recommended by the manufacturer. Sharp edges shall be avoided.

10.4.21 Every precaution shall be taken to ensure that cables and equipment are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to, the performance of the cables and equipment during operation.

10.4.22 Signalling cables shall not run with cables carrying high voltages or heavy currents and shall conform to the requirements specified in BS 7671.

10.4.23 Wherever both Signalling & Telecom cables are to be laid in the same trench/duct, common trench/duct may be used with brick separation between the two.

10.4.24 Signalling tail cables shall be mechanically protected to avoid being damaged from track side maintenance activities and shall be immune to any malfunction from electromagnetic interference.

10.4.25 All cables shall be adequately rated for their duties. All power cables shall be able to withstand full load current for peak operation when the equipment is at its ultimate capacity. The Contractor shall comply with the latest edition of IEE Wiring Regulations.

10.4.26 Unused cable cores/pairs of multi-core/pair cables shall also be terminated and marked so.

10.4.27 No underground jointing of cables shall be permitted.

10.4.28 Electronic Cable markers of proven make shall be provided for outdoor cables laid in trenches spacing of which shall be got approved by the Engineer.

10.4.29 Cable channels in floor of Signal and Telecom equipment rooms, PSS(S&T) room and ASM/panel room shall be provided with removable Aluminium checkered plate covers.

10.5 Marshalling and Termination

10.5.1 General

10.5.1.1 All Porta Huts and Location Boxes shall be prewired at a convenient site office of the Contractor to the extent possible and tested before being shifted to site for installation.

10.5.1.2 Crimping or other standard industry practice shall be used for terminating all conductors. Solder terminations shall only be used with the approval of the Engineer.

10.5.1.3 Wherever practical, multiple pin plugs and sockets shall be used to connect multi-core cables and wiring looms to all items of equipment. These shall have some form of keying to prevent incorrect equipment modules from being installed.

10.5.1.4 All wire and cable conductors shall be clearly identified at each end using durable shrink-on or tag type labels.

10.5.1.5 All wire and cable terminals shall be numbered and identified using appropriate tag type labels. A description of the terminating function shall be included.

10.5.1.6 The cables laid on trays shall be suitably marshalled for easy identification.

10.5.1.7 The cable terminations shall be secure enough to withstand vibration level, which is likely to be experienced in the railway environment.

10.5.2 **Cable Termination Rack (CTR)**

10.5.2.1 Cable Termination Rack (CTR) with 20% extra capacity for future expansion shall be provided in Signalling Equipment Rooms.

10.5.2.2 Only screw less terminals with isolation facility as per RDSO specification shall be used for cable terminations and fuse holders. These shall be got approved by the Engineer.

10.5.2.3 The outgoing circuits connecting to external circuits liable for lightning or high induced voltage, lightning arrestors and surge protection devices shall be provided with the required earth connections. For details of this protection, please refer to para 10.8 (Lightning and Surge Protection).

10.5.2.4 The Cable Termination Rack (CTR) shall be equipped with copper earth bar to which all cable shields shall be connected. The copper earth bar shall be connected to the earth. For details please refer to para 10.7 (Earthing).

10.5.3 **SER/Trackside Interfaces**

10.5.3.1 All interfaces between SER equipment and trackside equipment shall be via easily removable railway Signalling type fuses or shorting links as appropriate. The design of these links shall make it possible to measure all current and voltage levels at these interfaces. By removing these links, it shall also be possible to completely isolate both the outgoing and return feeds of each interface circuit.

10.5.3.2 All interfaces to trackside equipment shall be provided with adequate lightning protection devices in order to prevent any sensitive electronic equipment connected to them from being damaged.

10.6 Labelling

10.6.1 Descriptive labels shall be provided for all cabinets, enclosures, panels, assemblies and sub-assemblies.

10.6.2 Labels shall be of engraved type, with durable markings and shall have character size not less than 6mm high.

10.6.3 The details of the labels including the material and size of the characters and sample of the labels shall be submitted to the Engineer for review.

10.6.4 Labels and notices on equipment shall be fixed with roundhead brass screws or self tapping screws. Stick-on labels or fixing by adhesive shall not be accepted.

10.6.5 All enclosures containing terminals or exposed live parts where a voltage exceeds 120 volts shall have a label with lettering indicating the maximum voltage present in the enclosure.

10.6.6 Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical equipment.

10.7 **Earthing**

10.7.1 General

10.7.1.1 Earthing shall be provided for all indoor & outdoor Signalling installations to achieve the following objectives:

(1) to provide the safety to the operating & maintenance personnel against the electric shock on account of any potential (voltage) appearing on exposed parts with respect to earth or due to electromagnetic or electrostatic induction;

(2) to ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the Signalling equipment;

(3) to protect the equipment against build up of unduly high voltages, which can cause dielectric (Insulation) breakdown or damage to the equipment or their parts;

10.7.1.2 Earthing and other protective measures in the following paras are given only as indicative guidelines. The contractor shall design, manufacture, install and be responsible for safe and correct working of all equipment/subsystems under the scope of the contract.

10.7.1.3 The contractor shall submit the design for earthing, surge and lightning protection of all Signalling equipment for review and approval. OEM's original data sheets of the proposed devices shall also be submitted.

10.7.2 Requirements of effective Earthing

10.7.2.1 The Earthing system shall meet or exceed the requirements of IEEE 1100, NFPA 780 and IEC 62305 or relevant International standards.

10.7.2.2 Earthing and other protection devices shall be designed to accomplish the following minimum requirements but not limited to:

(1) protect personnel and equipment from electrical hazards, including lightning;

(2) reduce potential to system neutrals;

(3) reduce or eliminate the effects of electrostatic and electromagnetic interference arising from within the WDFC on account of traction voltages, traction return current, electric locomotive characteristics and other extraneous sources;

(4) provide a proper earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies.

10.7.2.3 The earthing system shall be so designed so as to give earth resistance within 1 Ohm at all locations and under all climatic conditions.

10.7.2.4 Any electrical joints in the earthing system shall be properly brazed and protected from moisture ingress by using proper wrapping, sealing with waterproof tapes or such other measures.

10.7.2.5 For the purpose of measurement of earth resistance, a small interconnecting copper strip of appropriate cross-section shall be provided in the ring earth in a small manhole chamber so that the ring earth can be broken from the loop.

10.7.2.6 The earthing methods, design and details shall be submitted to the Engineer for review and approval.

10.7.3 Earthing of indoor equipment

10.7.3.1 The Main earth provided in the station buildings shall be extended to S&T equipment rooms. The Contractor shall provide earthing cable of minimum 16 mm² from the PSS room to the Signal Equipment Room (SER) and terminate on copper earthing strips of sufficient size and specifications. These earthing strips shall be used to extend individual earths to cables and racks/equipment etc.

10.7.3.2 In OCC, earthing strip provided by ST P-5 Contractor may be utilised by CT P-14 Contractor for earthing any equipment provided by him.

10.7.3.3 In order to ensure a captive earth connection to the cabinets and racks in SER, a minimum cross-section of 16 mm² copper cable must be used for earthing.

10.7.3.4 The cabinets within a row shall be conductively connected by means of screws and contact washers.

10.7.3.5 In case that one of the cabinets/racks is removed, it must be ensured that the other cabinets in the row remain earthed. To ensure this, individual equipment racks shall be earthed by individual cables from earthing strips & looping from rack to rack shall not be done.

10.7.4 Earthing of outdoor installations

10.7.4.1 An earthing system shall be designed to ensure personnel safety and protection of installations against damage.

10.7.4.2 To achieve the primary goal of assuring personnel safety and damage control, a low impedance path shall be made available to the current generated due to lightning or power system fault. The potential differences between any two points shall be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimise shock hazards to system staff.

10.7.4.3 To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing shall be designed to minimise the noise voltage generated by currents from two or more circuits flowing through a common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

10.7.4.4 All outdoor installations listed below but not limited to, shall be earthed to the nearest Main earth bus bar with a minimum 16 mm² copper conductor:

(1) metallic sheath & armoury of all cables at regular intervals;

(2) location boxes;

(3) racks;

(4) signal posts;

(5) Lifting Barriers at Level crossing Gates;

(6) any other Signalling installation as may be necessary to cover complete scope of works defined in the Contract.

10.7.4.5 a) The Contractor shall develop Project wide Earthing and Bonding Management Plan. The Contractor shall coordinate and provide earthing system accordingly as per International practice.

b) Extension of Traction Earth from the agreed track side connection point to Signalling equipment shall be done by the Contractor as per approved system of Earthing Management Plan.

c) OHE masts and rails shall be connected to Traction Earth.

10.7.4.6 Suitable safety methods such as screen of wire mesh (earthed) shall be provided for safety of maintenance staff wherever there is infringement of equipment installation in the signal clearance zone as per IRSEM.

10.7.4.7 Wherever it is not possible to use earthing as per Clause 10.7.4.5 above, CT P-14 Contractor shall provide his own earth. Any earth provided by the Contractor shall be maintenance free and maintain its maximum earth resistance value of 1 Ohm for a minimum period of 5 years.

10.7.4.8 The metallic sheath and armoury of all cables shall be earthed as per the established practices in RE areas of the Indian Railways.

10.8 Lightning and surge protection

10.8.1 General

10.8.1.1 While the station buildings will be provided with general lightning protection arrangements, the protection against lightning surges

travelling through conductors into equipment shall be provided using appropriate devices.

10.8.1.2 Purpose of lightning and surge protection provision is to eliminate failures of Solid state electronic equipment due to high voltage transients and lightning.

10.8.1.3 Requirements of effective lightning and surge protection:

10.8.1.3.1 It shall be complying with IEC 62305.

10.8.1.3.2 Device lifetime shall not be less than that of the system for which it affords protection.

10.8.1.3.3 All signalling, supervisory and communications equipment shall be fully protected against damage from voltage surges or spikes which may appear in any part of the power supply or circuit as a result of power supply switching or lightning.

10.8.1.3.4 Surge protective devices shall be provided at the inputs and output of the PSS to protect the PSS and the load equipment against any power surge due to lightning, switching, etc.

10.8.1.3.5 Surge arrestors shall be provided at both the incoming signalling cable termination and the incoming power supply switches inside the SER to suppress any incoming voltage surge or spike.

10.8.1.3.6 All surge protection equipment shall be grouped together in close proximity to the main earth bus bar and be physically and electrically isolated from other signalling equipment. External signalling cables shall enter the equipment room or signalling apparatus box as close to the main earth bus and surge protection equipment as possible and as far as possible from the internal wiring.

10.9 Housing, Enclosure and Cabinet

10.9.1 All equipment installed shall be able to withstand vibration levels likely to be experienced in railway stations & along railway track side structures.

10.9.2 All design of housing and enclosure shall be submitted to the Engineer for review.

10.9.3 Unless specified otherwise, all equipment to be housed in outdoor environment (open areas etc.) shall be dust proof and water proof to IP 65 standard enclosures as a minimum. Open areas shall be the areas within reach of direct sunlight and rain.

10.9.4 All equipment cabinets shall be manufactured from mild steel sheet of at least 1.6mm thickness and shall have treatment for corrosion protection. The cabinet shall not be higher than 2200mm.

10.9.5 All cabinets installed in equipment rooms with false floor shall have cable entry at the bottom.

10.9.6 For floor mounted type cabinets, access to cabinets and sub-assemblies within cabinets shall be provided via removable front and/or rear doors equipped with locking facilities. Side panels shall be removable, if necessary.

10.9.7 Particular attention shall be paid to the ventilation of cabinets to ensure an acceptable condition for equipment inside. The Contractor shall submit, for the review of the Engineer, calculations proving that the temperature inside the equipment cabinet can be maintained within the temperature specifications of the equipment.

10.9.8 The layout of equipment shall be designed to provide easy access to every individual part from the outside.

∗ * * End of Chapter 10 ∗ * *

11. PACKAGING, SHIPPING, STORAGE AND DELIVERY

11.1 Packaging

11.1.1 General

11.1.1.1 The requirements on packaging, shipping, storage and delivery shall be as given in the GS.

11.1.2 Cable Drums

11.1.2.1 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.

11.1.2.2 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.

11.1.2.3 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.

11.1.2.4 Cables shall be supplied on drums in the longest possible lengths and within practical limits. The drum width when mounted on the rail vehicle shall not exceed the specified Gauge of the railway.

11.1.2.5 The maximum allowable diameter of cable drum shall be 2000mm. The use of cable drums with diameter in excess of 2000mm shall be subject to the review of the Engineer.

11.1.2.6 All cable drums shall be designed to be securely mounted on the rail vehicle with the mounting accessories provided by the Contractor for cable laying along trackside.

11.1.2.7 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.

11.1.2.8 Each drum shall bear a distinguishing number and label “WDFC Signalling System”, either printed or neatly chiselled on the outside of one flange.

11.1.2.9 Particulars of the cable, i.e. voltage, length, conductor size, number of cores, finish, section and length number, gross and net weights, shall be clearly shown on one flange of the drum. In addition, the words “Running End ‘A’” or “Running End ‘Z’” as appropriate shall be marked on the flange and the direction for rolling shall be indicated by an arrow.

11.2 Storage

11.2.1 The Contractor shall provide his own storage and facilities at his premises for storage of all items to be provided for this Contract before delivery to the Site for installation.

11.2.2 The Contractor shall maintain record of stored items for this Contract and make available to the Engineer for inspection upon request.

11.3 Delivery

11.3.1 The Contractor shall deliver all items supplied under this Contract to the Site as desired by the Engineer.

11.3.2 The Contractor shall include the delivery activities in his three month rolling programme and five week rolling programme to draw the Engineer's attention.

11.3.3 The Contractor shall ensure the Site is ready and in good conditions for delivery.

11.3.4 The Contractor shall ensure good conditions and security of the delivered items on Site.

11.3.5 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

11.3.6 No dangerous goods shall be delivered to the Site.

∗ * * End of Chapter 11 ∗ * *

12. DOCUMENTATION

12.1 General

(1) Operation and Maintenance Documentation is mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) The Contractor shall submit a submission programme. The submission program shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

(3) The Contractor shall provide configuration management to ensure that the system is correctly configured. The Contractor shall ensure that a configuration control program is maintained. The programme shall ensure that the configuration of each item is recorded and maintained during the life of the Contract including Defect Liability Period.

(4) The Contractor shall submit a Project Management Plan to the Engineer for review. The Project Management Plan shall identify the persons to be responsible and the methods and arrangement to carry out the Project Management.

(5) All Layout plans, drawings and documents shall be prepared by the Contractor.

(6) Symbols used in drawings shall be same as in use in Indian Railways.

(7) All documents shall be submitted for review and approval by the Engineer.

(8) OEM Manuals: All manuals/ Driver software CD's etc., whatever comes with the equipment purchased from vendors shall be handed over to DFCCIL.

(9) Warranty Certificates of OEMs: All Original Warranty Certificates of OEMs shall be registered in the name of DFCCIL. These warranty certificates received from the OEMs shall be passed on to DFCCIL.

12.2 List of Drawings

12.2.1 The drawings to be supplied by the Contractor shall be, but not limited to, the following:

(1) Preliminary Design

a) Signalling Plan (To scale);
b) # System Configuration Plan for OCC & TMS;
c) Power Supply Diagram for stations (To include maximum current on every cable & thus deduce cable size);
d) # Power Supply Diagram for OCC;
e) Power Supply Diagram for IBS;
f) Power Supply Diagram for Interlocked LC Gates;
g) Route Control Table.

(2) Detailed Design

a) Cable Core Chart;
b) Cable Route Plan (Separate for all stations & blocks sections);
c) Power supply Load Calculation for Junction & Crossing stations;
d) Power supply Load Calculation for OCC;
e) Power supply Load Calculation for IBS;
f) Power supply Load Calculation for Interlocked LC Gates;
g) Interface documents with other contractors;
h) Circuit Diagrams;
i) Station Working Rule Diagrams;
j) Equipment Rack details;
k) Cable Termination Rack Diagram;
l) Fuse Details;
m) Configuration data, parameters and settings;
n) Relay contact analysis;
o) Cable termination details of Location/ Junction boxes;
p) Square sheet for testing station interlocking.

(3) Equipment Layout Plans (including Cable troughs wherever required)

a) Signal Equipment rooms;
b) PSS rooms;
c) ASM office;
d) # OCC;
e) IBS;
f) Location/ Junction boxes;
g) Table of clearances as per SOD for trackside equipment.

(4) O&M Manuals

(5) As built drawings

a) For items under (1), (2) and (3) above and
b) Bill of quantity of equipment on location basis.

- Original design document prepared by ST P-5 Contractor shall be updated for equipment addition by CT P-14 Contractor. While doing so, need of similar updating by ST P-17 Contractor for JNPT-Vadodara section, if not done already, shall be kept in view.

12.3 Submission requirements

(1) The Contractor shall include records of amendment in each submission with the following details:

a) Revision history and status of the submissions;

b) Description on changes for each revision;

c) The names & signatures of the Contractor's designer, reviewer and approver for authorisation of the submission indicating proper design check has been carried out before submitting to the Engineer.

(2) The revision status and date of preparation of the submission shall be clearly indicated at the header of each page of the submission.

(3) The first submission shall be version A and subsequent revisions shall be version B, then version C, so on and so forth until document is approved by the Engineer. First approved version shall be version 0 and subsequent revisions shall be version 1, then version 2, so on and so forth.

(4) The Contractor shall maintain record of the submissions and updated records shall be included in the Monthly Progress Report. The submission records shall include the following details:

a) Submission number;

b) Submission title;

c) Revision history;

d) Status of Engineer's response for each revision;

e) Submission dates and dates of return from the Engineer for each revision;

f) Current status.

12.4 Levels of submission

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

a) System level related submissions;

b) Equipment level related submissions;

c) Installation design related submissions;

d) Design calculations;

e) Management plans and procedures;

f) Approval certificates;

g) Miscellaneous submissions.

(2) System level 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.

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

(4) Installation design related submissions shall include:

a) The installation methods and procedures for different types of installation activities;

b) Drawings showing the equipment locations and positions, subsystems coverage;

c) Schematic and wiring diagrams;

d) Cable core chart and numbering scheme;

e) Equipment mounting details;

f) Configuration data, parameters and settings;

g) Cable route drawings;

h) Layouts in equipment racks, in equipment rooms, trackside and all other equipment locations.

(5) Design calculations shall demonstrate the performance of the system and subsystems.

(6) The Contractor shall submit a copy of certificates from relevant parties and authorities as required including equipment calibration certificates from manufacturers and laboratories.

12.5 As-built documentation

(1) The as-built documentation shall describe the system as installed and provide sufficient information for users, maintainers and developers to execute their responsibilities.

(2) The configuration data table shall be prepared for each individual subsystem and on an item-by-item basis as well as on location basis.

* * * End of Chapter 12 * * *

13. OPERATION AND MAINTENANCE SUPPORT

13.1 General

(1) Operation and maintenance support is mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) The Contractor shall investigate all failures, major failures, repetitive failures, installation and design defects and take all necessary corrective actions throughout the Contract period.

(3) The Contractor shall investigate interference problems either from or to the systems of other Contract packages and take all necessary corrective actions throughout the Contract period.

13.2 Operation and Maintenance Document

The Operation and Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for review not later than six (6) months after the award of the Contract.

13.3 Operation and Maintenance Plan

(1) The Maintenance Plan shall describe the Contractor's proposed maintenance regime for preventive and corrective maintenance of the system including but not limited to the following:

a) Maintenance philosophy and approach;
b) All necessary tasks for first line, second line, third line and corrective maintenance;
c) Frequency of each maintenance task.

(2) The Contractor shall include the following information on each maintenance task described in the Maintenance Plan:

a) The equipment, sub-systems covered in the task;
b) Step by step procedure to carry out the task;
c) Tools and test equipment required for each task;
d) Diagrams and flowcharts by illustration, if applicable;
e) Adjustment procedures for all field adjustable units;
f) Recovery procedures, if applicable;
g) Precautions to be followed by maintenance personnel;
h) Estimated duration and manpower required.

(3) In addition to the Maintenance Plan, the Contractor shall also submit a Yearly Routine Maintenance Schedule to the Engineer for review and shall indicate the schedule of maintenance tasks in a calendar year.

(4) The Maintenance Plan shall be aligned with DFCCIL's maintenance policy.

13.4 Software Support

13.4.1 General

(1) Software support is mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) The Contractor shall provide all changes, debugging, updates, modifications and upgrade of all the software developed or delivered for the system including data configuration tables free of cost if such changes are necessary and in order to maintain the normal operation and meet the requirements given in this Particular Specification.

(3) Software updates shall be provided as and when becoming available till expiry of Defects Notifications Period.

(4) The changes and modifications of the software shall not degrade the performance or have adverse impact on the system.

(5) The Contractor shall maintain backup copies of all software developed or delivered for the System.

(6) The Contractor shall ensure that all new versions are fully tested and validated and reviewed without objection by the Engineer prior to loading into the system.

(7) The Contractor shall provide training for the Employer's staff for use of new version, as and when incorporated.

13.4.2 Security obligations

Within fourteen (14) days of the installation of any software, which is developed or modified for this Contract, into the permanent works by the Contractor, the Contractor shall submit to the Engineer for retention by the Employer two (2) backup copies of the software, which shall include, without limitation:

a) All executable code including all data configuration tables;

b) All design documentation relating to the software;

c) Any specified development tools required for maintenance of the software including but not limited to editors, compilers and linkers.

13.5 Support during Defects Liability Period

13.5.1 General

(1) Support during Defect Liability Period is mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) During the first three months of Defect Liability Period, the Contractor shall provide necessary guidance to O&M staff in routine maintenance so that staff is able to carry out this activity independently as per training imparted for the same.

(3) The Contractor shall provide workshop repair services of all defective and faulty items of the system.

(4) The Contractor shall provide support and call-out services to the Employer as required for restoration of the System to normal operation in case any faults or defects are found.

(5) The Contractor shall submit a maintenance manpower plan showing the Contractor's organization and committed resources level available for all types of activities to be carried out within the Defect Liability Period.

(6) The Contractor shall ensure that all his staff who provide maintenance support are competent and have sufficient training in the sub-system for which they are responsible.

13.5.2 Workshop Repair

(1) The Contractor shall collect and repair defective parts that are removed from the system during maintenance or from the Employer.

(2) The Contractor shall perform all necessary adjustments or alignments 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 equal to or of higher specification than the original components in his repair activities.

(4) The performance of the defective parts after repair shall not be degraded or deteriorated due to repairing.

(5) The maximum turnaround time for workshop repair shall be less than twenty eight (28) days. The turnaround time shall start to count when the defective parts are removed from the system and end when the parts are repaired and returned to stock or the system. Any extension of workshop repair time shall be got agreed by the Employer.

13.5.3 Support and call-out services

(1) The support and call-out services shall be available 24 hours per day and 7 days per week.

(2) The Contractor shall provide sufficient number of competent and experienced staff for the support and call-out services.

(3) The Contractor shall provide a list of maintenance staff together with the contact landline/mobile telephone numbers who can be contacted for support and call-out services.

(4) Any changes in the call-out numbers and the maintenance staff shall be notified to the Engineer at least two weeks before such changes become effective.

(5) The Contractor's staff shall reach the site for maintenance support within one hour upon receiving the call-out request from Engineer and shall proceed to

perform corrective actions to restore the system to full normal operation.

(6) The Contractor shall take every precaution to protect existing equipment from damage and make good any damage caused.

13.5.4 Monthly Maintenance Meeting

The Contractor shall attend the Monthly Maintenance Meeting with the Engineer to discuss the maintenance matters during the Defect Liability Period. The dates and agenda of the meeting shall be agreed with the Engineer.

13.6 Spares, Special Tools, Diagnostic equipment and Test Equipment

13.6.1 Spares

(1) Spares, Special Tools, Diagnostic equipment and Test Equipment are mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) The Contractor shall provide his own spares during installation and commissioning period as well as for support during the Defects Liability Period. The Contractor shall also provide separate spares for the Employer to enable the Employer to operate and maintain the system.

(3) Recommended spares shall not be less than the scale given below:

S. No.	Item	Unit	Quantity
1.	Underground Cables.	Km	5% of the total cable laid subject to a minimum of 1 km of each type.
2.	All other cable & wires.	m	5% of the total cable/ wire used laid subject to a minimum of 100 meter of each type.
3.	Power supply cards/ modules (equipment power supply cards/ modules including PSS) complete with interconnecting cables and connectors.	Nos.	20% of each type installed.
4.	All other electronic cards/ modules complete with interconnecting cables and connectors.	Nos.	10% of each type installed.
5.	All rail mounted equipment complete with interconnecting cables and connectors.	Nos.	20% of each type installed.
6.	MCB, surge protection device,	Nos.	10% of each type installed.

S. No.	Item	Unit	Quantity
	fuses & terminals.		
7.	Mechanical signalling items (except bare racks and cabinets).	Nos.	5% of each type installed.
8.	All other equipment.	Nos.	10% of each type installed.
9.	All other interconnecting cables/ connectors not included in 1 to 8 above.	Nos.	10% of each type installed.

(4) The Contractor shall submit the list of contract (maintenance) spares within six (6) months after the Commencement Date of the works to the Engineer for review. The list shall include:

a) Grouping by subsystem, diagnostic and test equipment and special tools, as applicable, for stocking identification;

b) A cross-reference and indexing system for replacement components common to more than one subsystem;

c) Detailed description with references and correlation with the maintenance manuals;

d) Contractor's own spares.

(5) The Contractor shall keep and maintain sufficient stock of his own Commissioning Spares and Defects Liability Spares. In addition, in determining the list of spare parts for the Commissioning Spares and Defects Liability Spares, the Contractor shall provide calculation to support the proposed types and quantities with the following taken into account:

a) The expected failure rate of the parts;

b) Population of the parts in the system;

c) Criticality of the parts in the system;

d) Availability and MTBF figures of the system;

e) Spare delivery lead time;

f) Workshop repair turnaround time.

(6) The Contractor shall submit the list of Commissioning Spares, with the types and quantities of spares the Contractor intends to hold, at least three (3) months before the commencement of the installation activity to the Engineer for review.

(7) The Contractor shall submit the list of Defects Liability Spares, with the types and quantities of spares the Contractor intends to hold, at least three (3) months before the commencement of the Defects Liability Period to the Engineer for review.

(8) The Contractor shall include details of the stock of the Contractor's own spares in the Monthly Progress Report. The status of the spares, either in store or

under workshop repair, shall also be included.

13.6.2 Contract spares for Employer's operational and maintenance requirement:

(1) The Contract spares shall include, but not limited to, spare modules, sub-assemblies, special components and fuses.

(2) The Contractor shall submit quantities of each type of spare modules, sub-assemblies and parts and those recommended by him.

(3) The shelf life of the equipment shall also be mentioned by the Contractor.

(4) Any item not included as spare in the offer and subsequently found to be necessary during Defect Liability Period or during Maintenance contract period (if any) shall be supplied by the Contractor FREE OF COST.

13.6.3 Special Tools, Diagnostic equipment and test equipment:

(1) The Contractor shall provide the Special Tools, Diagnostic equipment and test equipment.

(2) The Contractor shall submit quantities of each type of Special Tools, Diagnostic equipment and test equipment and those recommended by him. The quantities shall be equal to number of IMDs + Sub Depots increased by 20%.

* * * End of Chapter 13 * * *

14. TRAINING

14.1 General

(1) Requirements for Training are mentioned in GS in general. This chapter mentions particular requirements for Signalling System.

(2) Training support shall be referred to in section 1.3 and as follows.

14.2 Scope of Training

(1) The objectives of this training are as under:

(a) to enable the Employer's maintenance personnel to maintain the commissioned signalling system and

(b) to enable the Employer's Key Instructors to be competent to deliver future courses for other employees of the Employer.

(2) The training shall be imparted on various Systems. Aspects covered shall include, but not be limited to, the following:

(a) Operating features and functional principles of the relevant Systems;

(b) System engineering aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination;

(c) Details of major equipment and components used in the System;

(d) System operating and maintenance management procedures and

(e) Control and monitoring systems for each System.

(3) The training shall be in India and abroad including training at manufacturing facilities as appropriate.

14.3 General Requirements

(1) This section of the specification covers the requirements for a Training Programme to train the Employer's maintenance, operating and training personnel. The Training Programme shall enable the basic staff to operate, service, enhance, maintain and interact with the hardware, software and firmware such that the systems and associated equipment will perform in accordance with the specifications of this contract.

(2) The Contractor shall provide comprehensive training to the Employer's maintenance, operating personnel and Key Instructors.

(3) The Contractor shall provide training rooms, competent training instructors, training manuals, all necessary aids and materials in support of all training courses. In addition to supply of printed manuals to all trainees, the training manuals shall be submitted in original plus ten (10) hard copies and in electronic format to the Engineer.

(4) The training instructors shall be qualified and competent with sufficient years

of practical experience in the relevant fields and possess good communication skills. The training instructors shall be competent staff of the Contractor, the subcontractors or the equipment manufacturers.

(5) Training in India or abroad shall be conducted in English Language. The respective training manuals will be provided in English. If asked by Engineer, the training manuals will be provided in Hindi also.

(6) Should, in the opinion of the Engineer and due to good reasons, any of the Contractor's training instructors not be 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 training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at place of manufacture, assembly or testing or at such other locations as may be necessary. All places of training shall be subject to be proposed by the Contractor and approved by the Engineer.

(8) The training courses and/or sessions shall include system performance requirements and all major equipment and works engineered by the Contractor.

(9) The Contractor shall provide full-time on-Site management, co-ordination and supervision of the entire training programme to ensure the continuity of classes and proper distribution of training materials and be responsible for interfacing with the instructors.

(10) The Contractor shall be required to arrange technology transfer and training to the Employer's staff in respect of design, installation, testing and commissioning of the System and each subsystem to enable them to work as trainers. The Employer will nominate up to three (3) persons for each subsystem for this training.

(11) The Contractor shall submit assessment reports on the performance of individual trainees to the Engineer. Training evaluation shall be required at regular intervals to monitor the progress and suitability of the training programme. 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 programme as soon as possible.

(12) Throughout training programme, the Engineer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

(13) If required by the Engineer, any one or more of training courses may be repeated during currency of the contract to train additional batches of staff.

14.4 Training Plan

14.4.1 The Training Plan shall be prepared by the Contractor and submitted to the Engineer for review not later than six (6) months after the award of the Contract.

14.4.2 The Training Plan shall include, but not be limited to, the following:

(1) the program of the training courses and submission schedule of the training materials;

(2) overview and description of objectives of each training course;

(3) the location where the training courses to be conducted;

(4) set ups for practical exercises;

(5) the Contractor's training organisation chart, including the role and responsibilities of individual key persons;

(6) the qualifications and experience of the training instructors; and

(7) details of training simulators to be provided or developed, if applicable.

14.5 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 phase 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 instructions in the maintenance of the installations.

(3) The Contractor shall provide training courses for each of the sub-systems including but not limited to:

a) EI including BPAC & IBS;

b) PSS

c) Track Vacancy Detection System and

d) TMS.

(4) 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.

14.6 Operating Staff Courses

(1) The operating staff training courses shall be developed to provide all necessary knowledge and skills for operating staff of the Employer to operate the system under normal, degraded and emergency situations and recovery from minor or simple faults. In particular, the training courses shall include the following as minimum:

a) Overview of the relevant System;

b) Description of the operation principle of all Systems and Subsystems;

c) Description for operating technical equipment;

d) Operational features and functions;

e) Familiarization and use of all man-machine interfaces involved;

f) Reading and interpretation of system status and alarm messages or indications;

g) Normal and degraded operating procedures;

h) Operating procedures under emergency situations;

i) Procedures for recovery from minor or simple faults;

j) Use of Operator's Manuals and documentation;

k) Detailed knowledge and correct application of operating rules and procedures;

l) Local knowledge of stations and the line.

(2) Particular exercises shall be included in the operating training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple fault recovery.

14.7 Maintenance Staff Courses

(1) The maintenance staff courses shall be developed to provide all necessary knowledge and skills:

a) To perform full maintenance, including both preventive and corrective maintenance on each System and

b) To perform system Engineering management including system parameter configuration, enhancement, adjustments and provision of new equipment and components.

(2) Training shall be provided on all aspects of Maintenance of the System including proprietary or third party equipment and software. Software shall also cover custom-designed software or software driven utilities to form part of the Preventive and Corrective Maintenance Procedures.

(3) Level & Types of Maintenance

a) Preventive maintenance means routine or scheduled maintenance requirements that must be performed on the system (including overhaul) to ensure that the operation of the system is maintained.

b) Corrective maintenance means unscheduled troubleshooting maintenance requirements that must be performed on the system so that the system can be returned to normal service as soon as possible.

c) First level maintenance means corrective maintenance procedures that must be performed on site so that the system can be restored back to normal service as soon as possible.

d) Second level maintenance means corrective maintenance procedures that are implemented at workshop level to restore individual components and parts back to normal operation as soon as possible.

(4) Training shall be based upon a 'two-stage' concept as follows:

a) Stage one shall consist of training on the basic concepts and principles. These shall include system configuration, system specification, system operation & control, preventive maintenance procedures, troubleshooting/ repair concepts, interpreting diagnostic test reports and equipment or system test & restoration.

b) Stage two shall consist of on-the-job training on Preventive and Corrective Maintenance.

(5) The Contractor shall determine the contents of the courses and the courses shall include the following as minimum:

a) Overview of the relevant System;

b) System features and functions;

c) Operating principles;

d) Safety precautions to be taken;

e) Description of system components;

f) Test and commissioning procedures;

g) Use of Diagnostic equipment, test equipment and special tools;

h) Reading and interpretation of alarms, 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, operating 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;

o) Use of software such as peripheral control and configuration, utility, database structure, generation and modification.

(6) Practical exercises shall be provided for each trainee to practice the following as minimum:

a) Use of diagnostic equipment, test equipment and special tools;

b) Preventive maintenance;

c) Fault diagnosis and troubleshooting with induced faults set by the instructor to simulate real-life situation;

d) Faulty modules or cards replacement and restoring the system to normal operation;

e) Installation and Commissioning of sub-systems/systems.

14.8 Training Materials

(1) Training Aids, Training Materials and Training Devices shall be of durable construction and shall become property of the Employer on completion of Training.

(2) The Contractor shall provide all Training Aids, Training Materials, Training Devices, Special Tools, Diagnostic equipment and measuring instruments, fixtures, models, or other equipment required to train the Employer's maintenance staff and Instructors.

(3) The Contractor shall prepare Training Manuals and submit them to the Engineer for review at least 90 days prior to the start of the Training Demonstration.

(4) Throughout the Contract, it shall be the responsibility of the Contractor to supply all changes and revisions of the Training Manuals to the Engineer.

(5) Training Manuals shall become the property of the Employer.

(6) The Employer reserves the right to copy all Training Materials for use in Training Courses.

(7) All the training materials shall be accurate and match with the actual design of the System.

14.9 Training Records

(1) The Contractor shall keep attendance records of trainees. The Contractor shall devise a system and standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees. The system and standards shall be submitted to the Engineer for review at least four weeks before commencement of the training course.

(2) The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.

14.10 Course Evaluation

14.10.1 The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weightage 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.

14.10.2 Upon completion of each training course, the Contractor shall distribute the questionnaires to the trainees to fill in.

14.10.3 The Contractor shall submit a training report to the Engineer for review within two weeks after completion of each course. The training report shall include a summary of the training course conducted, the results of trainees' assessment and the course evaluation questionnaires.

14.10.4 The Contractor shall submit the course evaluation criteria to the Engineer for approval.

* * * End of Chapter 14 * * *

Annexure 1: Train Monitoring & Diagnostic System – Functional Requirement Specification

1. SCOPE

1.1 Train Monitoring & Diagnostic System (TMS) is proposed to be provided in Dadri - Rewari section (Phase 2) of DFCCIL Western corridor.

1.2 TMS shall be designed to include complete Signalling system covering full line of above mentioned section. If required, TMS shall be commissioned in two or more phases depending on progress of works.

1.3 Wall display shall include display of SCADA also.

1.4 Backup Control Centre (BCC) shall be provided by another Contractor.

1.5 This Annexure should be read in conjunction with Annexure 7-3.

2. TMS SYSTEM ARCHITECTURE

(i) System shall have highly scalable architecture. It shall be possible to increase/reduce the number of monitored equipment flexibly by adding/reducing the number of servers.

(ii) There will be redundancy in servers with Main and Standby configuration. Both Main and Standby servers will be normally ON and updated with latest data/status.

(iii) Normally system will be working from main server. In case of its failure, standby will take over automatically and generate an alarm.

(iv) It shall be possible to change the system load manually from Main to Standby and vice versa.

(v) Provision shall be made for automatic transfer as well as forced takeover between Main OCC & BCC. Refer Annexure 7-3 for details.

3. SYSTEM RESPONSE TIME

The system shall be so designed so as to achieve the overall objective of providing real time information related to train operation in section proposed to be covered by TMS. The following response time shall be considered in design:

i) The response time between a change of state at a wayside station and its display at OCC shall not be greater than 2 seconds.

ii) The time taken between initiation of a query relating to data /result /report and its response on terminals shall be as small as possible.

4. AGGREGATION OF INFORMATION

The status and alarms of all Signalling equipment of Block sections will be sub divided into two halves (if necessary) and sent from site to nearest station. At the station, this data will be added to similar data emanating from station equipment and sent to OCC through LAN on OFC. Contents of two halves shall be got agreed by the Engineer.

5. LIVE INDICATIONS

5.1 Live Indications in Control Office (On Overview Mimic Indication Panel):

i. Overview Mimic Indication Panel consisting of video panels shall be provided to display an overview of the Dadri – Rewari section of DFCCIL Western Corridor Phase 2 network covered by TMS. Black background shall be used for getting proper contrast. Other colours used shall be such as to give bright and easily distinguishable display.

ii. The Mimic Indication Panel shall display all Axle Counter Track sectioned lines and all interlocked signal aspects of track layouts of stations & Block sections from Dadri to Rewari. Location of Porta Huts shall also be shown.

iii. The Overview Mimic Indication Panel unit shall display important indications of wayside stations panel, Block proving by Axle Counter (BPAC) status, aspects of signals in Block sections, status of Axle Counter Track sections and LC gates etc. The panel will also provide alarm indications of failure of points, signals, Axle Counter Track sections etc. as the case may be. Less significant objects/indications like non Axle Counter Track sectioned sidings etc. will be shown with a thick line of suitable colour on the overview panel.

iv. NOT USED.

v. The Overview Mimic Indication Panel unit shall display the occupancy of various track sections along with the train description. Train ID box shall indicate different colours for different type of loads e.g. Container, Petroleum products, Food grains etc. In case train number is not keyed-in, the same shall be shown as flashing unknown train identifier mark along with Non Described Alarm (NDA). Alarm will stop as soon as the train number is keyed in by the controller / ASM.

vi. If a train has stopped at any place enroute for more than the prescribed time, an alarm shall be raised to draw attention of the controller.

vii. It shall be possible to update changes in yard layout through software from the maintenance terminals without any requirement of change in the hardware. The uploading time of software changes shall be minimum and it shall be possible without complete shutdown of the indication system.

viii. It shall be possible to show the temporary speed restriction by showing the Tag box or by any other means.

ix. Text in Mimic Indication panel showing signalling layout and status shall be readable from seats of Chief Controller and all Section Controllers.

x. Text in Mimic Indication panel showing SCADA shall be readable from seats of Chief Controller and all Traction Power Controllers.

5.2 Live Indications to Train Controller Terminals

i. Section controller / Chief controller terminals (work stations) will consist of 3 monitors each of size of 21"/54 cm. All the features available on Mimic panel shall also be available on these terminals.

ii. All terminals shall be able to display complete information of yards covered by TMS with details of Axle Counter Track sections, signals, Points, LC gates etc. Any failure of signalling system at any station shall be available in audio & visual form to draw attention of controller. It shall be possible to acknowledge and stop the audio alarm of failures.

iii. NOT USED.

iv. On line display of train movements shall be available on the terminals with train details such as Train No., type of load, Loco Pilot etc.

v. Ordinarily it shall show complete yard at a time including all Axle Counter Track sectioned and Non-Axle Counter Track sectioned lines. Big yards can be divided into many parts, with provision of selecting any one part on a screen with facility of scrolling to see the full yard on one /more screens.

vi. If train identification has not been entered by the train dispatching station, concerned Section Controller shall have facility for entering it on getting NDA.

vii. It shall be possible to view train graphs. The train graph shall also cover advance charting showing traffic blocks. Train graph lines/Train ID box shall have tag with details of train, crew etc. These features are further described in para 5.3.

viii. In case of unusual events and delays to trains, system will prompt the controller to enter the reason and other details in the prescribed format.

ix. The details of occupancy of berthing lines and sidings shall also be available on the terminal.

x. The crew details available in the system shall also be available on the terminals provided with CHC, Dy. CHC, etc. apart from being available on SCOR & ASM work stations.

xi. All the traffic and urgent alarms described in para 9.3 shall be available on these terminals.

5.3 Live Indications on Terminals provided with staff at Stations /ELMD / Lobbies etc.

i. OCC and stations shall be provided with workstation type terminals having capability of graphic display. Remaining other locations, ELMD and lobbies will be provided with industrial Grade PCs.

ii. ON Line display of train movements (including description) along with layout and status of signalling will be available on workstations as available on Section Controller's terminals.

iii. It shall be possible to input TRAIN ID in 8 digits from these terminals along with other information such as destination, type of load, crew details etc. System will generate an audio & video alarm on ASM's terminal as well as in OCC, if train ID has not been filled by concerned Station Master.

iv. It shall be possible to query the system regarding details of trains, cancellation, rescheduling, delays, diversions etc. either through menu driven commands or through SQL commands.

v. Details of vehicles stabled on sidings at concerned station shall be displayed.

vi. Whenever a train leaves / enters the control area or is put out of the system by placing it in the siding or sending it to ELMD, it shall be automatically registered by the system. In addition to this, ASM shall have facility to delete / enter such trains.

vii. Flashing messages / instructions from the controller and information about expected arrival of next two trains on each line, cancellation and diversion of trains shall be displayed.

5.4 Live Indications to Signal Fault Controller Terminal

i. Signal fault controller terminal (work station) will consist of 3 monitors each of size of 21"/54 cm. All the features available on Mimic panel shall also be available on this terminal.

ii. Remote Condition Monitoring of Signalling gears at stations and in Block Sections shall be provided. This shall include logging in of events in central system, generating alarms, alerts and trends about performance / failures of these gears.

iii. The terminal shall be able to display complete information of yards covered by TMS with details of Axle Counter Track sections, signals, Points, LC gates etc.

iv. NOT USED.

v. Following 3 status information of each signalling sub system shall be available on his terminal:

- Serious Failure: Repair required immediately.
- Minor Failure: Not interrupt failure with which train operation is not affected.
- Normal status: Information that the equipment is working normally.

Similar information shall be available on various signalling maintenance terminals (for their jurisdictions) provided in OCC, at stations, IMDs etc.

vi. Any failure alarm of signalling system at any station shall be available in audio & visual form to draw attention of controller. It shall be possible to acknowledge and stop the audio alarm of failures.

vii. On line display of train movements shall be available on the terminal with train details such as Train No., type of load, Loco Pilot etc.

viii. Ordinarily it shall show complete yard at a time including all Axle Counter Track sectioned and Non-Axle Counter Track sectioned lines. Big yards can be divided into many parts, with provision of selecting any one part on a screen with facility of scrolling to see the full yard on one /more screens.

ix. All the traffic and urgent alarms described in para 9.3 of this Annexure shall be available on these terminals.

6. TRAIN DESCRIBER SYSTEM

i. It shall be possible to associate a train with an alpha-numeric ID called a train describer tag.

ii. A train describer tag shall be unique consisting of up to 8 alphanumeric characters displayed in a text box.

iii. The train description tag shall track the train in sections monitored by TMS.

iv. The Train Describer System shall be capable of automatically assigning train describer tags from a train number queue to trains originating at the stations covered by TMS.

v. The operator viz., SCOR and / or the ASM at entry point shall be able to edit the train describer tag queue.

vi. The operator viz., SCOR and / or the ASM at entry point shall be able to stop the automatic assigning of train description tag temporarily as mentioned in para iv above.

vii. The color of the train describer tag box shall be different for different type of train loads e.g. Container, Petroleum products, Food grains etc.

viii. The Train Describer System shall be able to register in the Software & display following abnormal conditions:

a. single Axle Counter Track section failure;
b. faulty position of points;
c. change in direction of a train;
d. division and joining of trains;
e. unidentified trains;
f. trains passing a signal showing a stop aspect;
g. more than one train on the same Axle Counter Track section;
h. Wrong marking of object/functions.

ix. Abnormal disappearing of train describer tag shall generate an alarm and display in different colour.

x. The Train Describer System shall be able to handle the commands for

a. Insertion of a train describer tag on a track or at a signal, which shall be assigned automatically to the train occupying the track;
b. Moving a train describer tag to a different location;
c. Renaming a train describer tag;
d. Exchanging one train describer tag with another train describer tag;
e. Deleting a train describer tag.

xi. It shall be possible to find the location of trains by search command.

xii. It shall be possible to view list of trains in the Train Describer System with following criteria:

a. All trains;
b. Only operator identified (known) train;
c. Trains in a given direction;
d. Trains at or between specific station(s);
e. Unidentified or delayed or cancelled trains.

xiii. The Train Describer System shall send log records of the events logged including the following information to data base:

a. Movement of train descriptions (Axle Counter Track section to Axle Counter Track section details with timing);
b. Operator's commands to the Train Describer System;
c. System will display crew details from the detailed link available in crew management software on query from various terminals of controllers & lobbies.

7. MANAGEMENT INFORMATION SYSTEM

7.1 MIS Edit

The system shall allow user to enter any free text tag to be associated with any train.

7.2 MIS Reports

i. The system shall generate report for trains run late by prescribed reference.

ii. Based on the events logged and the operator input, the system shall generate following (but not limited to) reports:

- Various Train control charts;
- Various Punctuality reports;
- Bad runner report;
- Train Composition report;
- Punctuality analysis report in suitable format. This may be daily, weekly or monthly as per prescribed format;
- Analytical report of various unusual occurrences, i.e. signal failures, OHE breakdown, Loco failure, Sick wagons etc. This can be again generated on daily, weekly or monthly basis on prescribed format;
- Analytical report of crew link/ utilization;
- Total Maintenance Blocks granted / refused along with locations, time blocked, time cleared;
- Sectional running time taken by trains of any ID;
- Delay report of trains along with train nos., time delayed (at stations/mid-section) etc.;
- Difference between actual and scheduled running time in tabulated as well as in graphical form.

iii. The system shall allow user to create an unusual report, describing a failure with the department that it belongs to and the trains that were affected by it.

iv. The reports shall be generated in designated formats.

v. Report formats shall be customizable.

vi. It shall be possible to print generated reports using networked A3 Laser colour printers provided by other Contractors.

7.3 Train Graph

The train graph, as specified below (but not limited to), shall be made available on the terminals with CHC, Dy. CHC & SCOR:

i. The system shall plot historical train graph for analysis.

ii. It shall plot time on X axis and stations on Y axis.

iii. It shall be possible to show schedule time and the actual time in the same graph but with different colors.

iv. It shall be possible to show Goods/Special trains in different colors.

v. It shall be possible to select the direction of train and the line.

vi. On clicking / selecting a particular train graph, it shall give complete information about the train details viz. train no., crew information, load details e.g. Container, Petroleum products, Food grains etc.

vii. Advance charting: In case controller defines the Maintenance Block on particular line for particular time, system shall be able to prepare train graph showing advance/predictive movements of available trains in particular section in different colours.

viii. It shall be possible to deduce average speed of trains between any two stations.

7.4 Training Server and Terminals

i. Separate server and terminals shall be provided for simulation studies & training purpose. The replay of log, time table editing, editing of train graph etc. shall be provided on this terminal.

ii. It shall be possible to simulate and observe the effect of various parameters such as Speed restrictions, Change in yard layouts etc. on sectional density (capacity) and to produce train graphs in pictorial or tabular form. Simulation of the effect of addition / deletion of a signal shall also be possible. The parameters shall be decided in consultation with DFCCIL.

iii. Simulation of train movements: Train movement shall be simulated by occupying & releasing Axle Counter Track sections on sections in accordance with movement of trains.

iv. The replay of log shall be possible with predefined begin & end time.

v. The simulator shall work with the same data as the on line system or separate Master data can be kept on the system.

vi. The simulation shall be possible in real time or in reduced / accelerated time scale.

vii. The system shall be capable of simulating the existing time-table and compare it with actual running on periodic basis to create Management Information to identify any shortcomings in the system / time-table.

7.5 Crew Management System (CMS)

Crew Management System must be closely integrated with TMS to reap the benefits as indicated in (vi) & (vii) below.

i. Crew Management System shall be provided for Loco Pilots.

ii. Crew Management details shall be fed by lobby staff separately for every Loco Pilot. The database will have all the information related to personnel & safety of Loco Pilots.

iii. Software will prepare detailed link program based on data fed by lobby staff for crew.

iv. It shall be possible to change Loco Pilot booking details for next 24 Hrs.

v. Getting daily report of planned booking and actual booking of crew shall be possible.

vi. Monthly reports of individual Loco Pilots in terms of KMs & duty hours date wise shall be possible based on real time data from TMS.

vii. It shall be possible to calculate running allowance of crew based on real time data from TMS.

7.6 Interfacing of TMS with Crew Management System (CMS)

i. TMS will be suitably interfaced with this module to take automatically the crew details from the detailed link table or the online data fed by lobby staff. TMS, based on this information, will show online position of Loco Pilots on train details query on Controllers terminals. The online position of crew shall be available to lobby staff either on TMS terminal of lobby or separate Crew Management terminal having CMS loaded.

ii. In case online position is not fed by lobby staff, TMS will take data from detailed link table with suitable tag that data is from link table. It shall be possible to change the name of Loco Pilot when prompted to do so by server.

iii. It shall be possible to get query based details of crew like running details, etc.

7.7 Time Table Planning System (Offline)

i. Software for offline Time table planning shall be provided for the whole line.

ii. Data base of infrastructure like signal distances, permitted speed of trains, Signal interlocking, Axle Counter Track section lengths etc. required for generation of time table shall be provided on main/simulation server or on separate server. Based on this data, time table system software shall prepare a time table. It shall be possible to modify/edit the generated time table offline and after testing of same on simulator terminal, load it on the TMS system.

iii. Time table shall be able to give section wise train graph.

iv. Suitable interfacing shall be provided with TMS so that related data can be taken from timetable system to TMS or vice versa.

v. It is envisaged that the Time table preparation tool shall be available on a simulation terminal to aid the operator to prepare timetable.

vi. It shall also have simulation facility to find any Headway or crossover conflicts in the time table.

vii. The time table preparation module shall have following features:

a. The system shall have a standalone Windows based tool to do the timetable planning in the offline system.

b. It shall be possible to edit timetable.

c. It shall be possible to Create/Edit/Delete a train service.

d. A train service shall have following (but not limited to) attributes:

i. Train ID;

ii. Type of Train Load (Container, Petroleum products, Foodgrains etc.),

iii. Stopping pattern telling which station it stops at;

iv. Running section telling which path it takes;

v. Time at each stopping station;

vi. Length of train in number of wagons;

vii. Creating train ID; if required.

e. It shall be possible to use train service template while creating a new train.

f. It shall be possible to define trains for a specific day of the week.

g. The time table compilation and proving system shall calculate and generate number of train trips and train kilometers for all time table trains.

h. It shall be possible to transfer the timetable to TMS by authorised user only.

8. TRAIN GRAPH REQUIREMENTS FOR TIME TABLE SYSTEM

i. The train graph shall draw time in X-axis and stations on Y-axis.

ii. The train graph shall have facility to show different types of train loads in different colors.

iii. It shall be possible to select the direction and day for which the graph needs to be plotted.

iv. It shall be possible to take printout of train graph on a printer/plotter.

v. It shall be possible to take train frequency reports from the timetable database.

9. LOG AND ALARM SYSTEM

9.1 Event Log

i. All important events (command, indications, errors, system information etc.) shall be logged in a log SQL database for later printing and analysis.

ii. Log database shall be separated into 3 sections; system log, short term log & long term log. The time span of log will depend on the size of database and intensity of log events.

9.2 Replay of Event Log

i. The replay function shall show history of events that has happened earlier in the TMS system. The replay of train movement shall be on simulation terminal.

ii. When replay is started, the dynamic status for infrastructure, train number, system pretest and alarm list as well as the pictures on the screen shall be initialized.

9.3 Traffic Related Alarms

i. Vital traffic operator related alarms shall be:

a. Failure of any Signalling gear including Electronic Interlocking, I/O controller, PSS, Axle Counter, Signal Lamp, Point Machine, Line side Electronic Unit (LEU) of TPWS (Input to be provided by ST P-5A Contractor) etc. in the entire section under scope.

b. Routes not released after passage of train.

c. Alarms initiated by Health Monitoring Systems of Points, cables, PSS, Earth Leakage Detector, ACs provided by the contractor, Temperature inside air conditioned room of porta huts exceeding 27^0C etc.

d. Train Not Described Alarm (NDA).

e. Train waiting for more than 5 minutes at a manual stop signal not taken off.

f. Train stopping at OFF signal for more than 2 minutes.

g. Any other unscheduled train stoppage.

h. Any unscheduled train detention in excess of prescribed time.

ii. Alarms a, b and c above shall be displayed on the Signal Fault Controller terminal in addition to terminals of SCOR and concerned ASM. Concerned ASM will imply for a particular station with block section on either side. For these alarms, facility of SMS generation through GSM(R) for maintenance staff shall be provided.

iii. All the above alarms shall be arranged in priority levels in consultation with the Engineer.

iv. It shall be possible to prepare failure reports in approved formats and also print the same.

9.4 Network Related Alarms

i. All alarms not directly related to traffic operations shall be considered to be Network related alarms.

ii. These shall be displayed on the Network Management System terminal only.

iii. These shall be arranged in priority levels in consultation with the Engineer.

iv. Failure of Network Communication / inability to access any of the nodes, defective terminals and hardware & software failures shall initiate an alarm.

10. SOFTWARE DETAILS

1. All software shall be based on open system concept and shall be independent of type of processor or hardware platform.

2. It shall be based on co-operative or client server processing architecture with distributed processing logic.

3. Following modifications shall be possible without modifying the source program:

i. Facility to add users with password authentication;
ii. Facility to delete an existing user;
iii. Change the priorities allocated to users;
iv. Change areas of jurisdiction;
v. Change various particulars of a train;
vi. Introduce new alarms with varying priorities;
vii. Changing the details of any node;
viii. Introduction of new nodes;
ix. Create, modify and delete sectional area on the train graph display;
x. Change the various colours allocated for various trains tag;
xi. Change x & y coordinate scales ;
xii. Menu and contents of formats on ASM terminal;
xiii. Addition & alteration to the screen formats on VDUs at train originating stations;
xiv. Incorporation of additional infrastructure such as yards, sidings, new lines, extension of loop lengths etc.

11. INTEGRATION WITH TRAIN RADIO COMMUNICATION SYSTEM

i. Suitable arrangement will be provided for entering of Train ID in Cab radio at the starting station of DFCCIL route and its confirmation from TMS by Radio Server.

* * * End of Annexure 1 * * *

Annexure 2: Train Monitoring & Diagnostic System – Technical Specification

1. INTRODUCTION

1.1 This specification covers the technical requirements of the Train Monitoring and Diagnostic System (hereafter called TMS) for use on Dadri - Rewari section of Western Dedicated Freight Corridor Phase 2.

1.2 This Annexure should be read in conjunction with Annexure 7-3.

2. FUNCTIONAL REQUIREMENT SPECIFICATION (FRS)

2.1 Signalling work including TMS in western Corridor is divided into two phases as under:

Phase 1; Rewari-Vadodara, to be provided by ST P-5 Contractor
Phase 2: Dadri-Rewari and Vadodara-JNPT, to be provided by CT P-14 & ST P-17 Contractors respectively.

2.2 TMS shall be designed to work as an integrated system of both phases covering full line of Western corridor. Suitable interface shall be developed with ST P-5 Contractor to achieve this functionality. Refer Annex. 7-3 for details.

2.3 The system broadly envisages the functionality as described in FUNCTIONAL REQUIREMENT SPECIFICATION kept as Annexure 1 in Particular Specification.

2.4 Wall display shall include display of SCADA also.

3. GENERAL DESCRIPTION

(i) TMS is broadly computer based information storage cum retrieval system located in the control office. System collects Signalling information (signals, points, Axle counters, route setting etc.) from various station interlockings and Locations in Block Sections on real time basis. It also collects the train identification information from the train originating stations normally retrieved from Time Table or keyed in by concerned ASM/SCOR.

(ii) All the information is processed automatically by the system and movements of trains at various locations together with the status of Signalling gears is displayed on the controller's/ASM's video screen on selective station /section basis.

(iii) The TMS is to provide an effective system of regulating trains by monitoring their movements and facilitates in taking timely decision for diversion of trains, induction/withdrawal of locos etc.

(iv) The system shall also provide for generation of punctuality reports, unusual reports, train graphs, loco and crew links and other MIS related reports. These reports are mentioned in FRS.

(v) The technical requirements covered in the specification are minimum essential requirements.

(vi) The hardware of the system shall be based on the latest design philosophy and shall be based on the state of art technology. It shall be fault tolerant and modular. The equipment/subsystem shall be capable of continuous use at rated capacity for long duration on a sustained basis.

(vii) The bidder shall provide tender specific authorization from the manufacturer of mimic / Video display system in Original to quote for the tender.

(viii) The system shall be capable of being upgraded to CTC at a future date.

4. SYSTEM DESIGN SPECIFICATION

4.1 Proposed Sig. & Telecom Infrastructure of Western DFC

A. **Signalling**

i) Signalling work including TMS in Western Dedicated Freight Corridor is divided into two phases as under:

Phase 1; Rewari-Vadodara
Phase 2: Dadri-Rewari and Vadodara-JNPT

TMS is to be provided covering Dadri - Rewari section of Western Dedicated Freight Corridor of Phase 2. If required, TMS shall be commissioned in two or more phases depending on planning and progress of commissioning of works.

ii) List of Junction and Crossing stations is given in Annexure 3.

iii) Junction stations will have interconnection with nearby station of Indian Railways.

iv) All the LC gates will be interlocked. List of LC gates is given in Data Book Vol. IV of Bid Documents.

v) Block sections in Rewari - JNPT section will be provided with Automatic Signalling with signal spacing of about 2 Kms.

vi) Four aspect LED signals will be provided.

vii) Suitable PSS shall be provided to get reliable power supply for Signalling system.

viii) Stations will be provided with Electronic Interlocking and VDU type indication cum control panel.

ix) Train Protection and Warning System (TPWS) will be provided in Rewari-JNPT section to monitor observance of speed limits, stop signals etc.

x) Dadri-Rewari section will be provided with Absolute Block Signalling out of which a total of 3 long Block Sections will be provided with Intermediate Block Signalling (IBS).

B. **Telecommunication**

i) Optical fibre based communication system with drop and insert MUXes and STM equipment shall be provided at every station and GSM(R) base stations.

For TMS, required dark fibre or bandwidth as required will be provided for connectivity using LAN.

ii) GSM(R) based Mobile Train radio shall be provided.

iii) Digital Electronic exchange system.

iv) GPS clock.

C. **Train Operation**

i) About 50 trains are expected to run in each direction every day.

ii) Electric Loco Maintenance Depot (ELMD) will be located at Rewari.

iii) OCC will be in or around Ahmedabad city within about 15 Kms from Right of Way.

iv) Backup Control Centre (BCC) shall be provided by another Contractor.

D. **Details of Basic Application Data input to the system**

These are available in Annexure A attached to this specification.

4.2 System Design Considerations

The following will be the broad guidelines (not excluding the others) for the design:

i) The DFCCIL Western Corridor network as described in Para 4.1 above is to be considered during overall design of the system. The Network, Central Server, wayside station computer processing speed, memory capacity, and mimic panel capacity shall be sufficient for the same. The capacity of power equipment at OCC and at wayside stations shall be designed accordingly.

ii) It shall have provision to interface in future with any additional TMS system for new corridor.

iii) Future requirement mentioned above is only for design considerations and necessitate modular design of the system as a whole so that expansion can be done at a later date by minimum disruption to the system and at a minimum cost. However, the system shall be able to give performance as per Para 4.3. The Tenderer should be able to support conformance to Para 4.3 parameters during design as well as testing by suitable data.

4.3 Performance Requirements

The Central Server, communication server, entire network of control centre and FIUs shall have capacity to handle data for following infrastructure (approximate):

1. 60 Stations
2. 300 Simultaneous trains.
3. Indications considering Auto signal every 2 kms. and about 2 interlocked LC gates.

4. All lines except sidings fully provided with Axle Counter track sections between every two Auto signals as required. Clause 5.4.1.2(1) of the specification may be referred to for details.
5. Data inputs related to individual train time table.
6. TMS indications shall include: -

SR	OBJECT	NO. OF INDICATIONS	DETAILS OF INDICATIONS
1	Main signal	4	R, Y, YY & G
2	Shunt signal	2	ON & OFF
3	Point	2 + Lock	NORMAL & REVERSE
4	Axle Counter Track section	2 + Error	CLEAR, OCCUPIED & ERROR
5	Route	2	SET AND LOCKED & RELEASED
6	LC gate	2	CLOSED & OPEN
7	Auxiliary signals like A marker, Calling ON, G/AG marker	2	Calling-ON: OFF Others: Lit & Unlit
8	Train ID	1	8 DIGITS
9	Failure of points, signal lamps etc.		Flashing Indications

In addition, suitable indication of having blocked any particular gear shall be provided.

4.4 Expandability

The Central Server, communication server, entire network of control centre and FIUs shall have capability to be expandable to handle data by additional 20%.

4.5 Dynamic Performance

The commissioned system shall have the following dynamic performance parameters:

1. 300 simultaneous running trains;
2. 50 route commands per minute (after provision of CTC in future);
3. 200 other commands per minute;
4. 1500 indications per minute.

4.6 Automatic Route Setting (ARS)

It shall be possible to provide this facility in future along with CTC.

4.7 Component Grade

(i) All components including the critical components, ICs, Microprocessors etc. shall be of standard grade.
(ii) Work stations shall be of Industrial grade.

4.8 Scalability

The system shall be scalable to take into account expansion and the improvements in train operation and expansion of network.

4.9 Reliability

1. The data base structure shall be such that it provides full handshaking for processing each event so that hardware failures are detected and Data integrity shall be maintained. To have high reliability, both software and hardware redundancy shall be inbuilt in the design. The Tenderer shall provide details of the same. MTBF for each of the subsystems and complete system shall be declared by the Tenderer and calculations in support of the same shall be submitted along with the offer.

2. Reliability Requirements: The reliability measure for the TMS shall be Mean Time Between Maintenance Action (MTBMA). The system shall achieve a MTBMA of no less than 7 days.

4.10 Safety Integrity Level

TMS can have SIL0 or equivalent safety level.

4.11 Maintainability Requirements

1. Systems and Equipment Design

The system shall be designed to maximize availability during traffic hours, to minimize the amount of maintenance required to maintain the system and to ensure that any maintenance can be carried out with the minimum amount of time, skill and cost.

2. Service Life.

i) All components, materials, software and other support required to repair and service TMS shall be available for at least 20 years from the Engineer's taking over of the works or section.

ii) All updated components shall be fully backward compatible with the originally installed components.

3. The Contractor shall notify the Employer in writing prior to deleting any component of the system from general availability and submit written assurances that it can provide functionally identical replacement units. The notification period for the deletion of the component and written assurances shall not be less than the lead-time for ordering or manufacturing the component plus six months.

4.12 Flexibility

The system designed and implemented shall be flexible and modular enough to permit easy alterations/changes in terms of change in site data, addition or deletion of user, stations etc. and for easy reconfiguration to take into account future software/hardware developments.

4.13 Standard Systems

The communication protocols and hardware standards shall be to CCITT / ITU standards and the Tenderer shall demonstrate the same. The software used for TMS shall conform to UIC or any similar standards.

4.14 EMI /EMC Immunity

All systems shall be immune to DFC's 2X25 KV AC Traction, 25 KV AC traction of nearby Indian Railways and other EMI /EMC interference that can generally be expected from a highly industrial environment.

4.15 Fault Tolerance

The system shall be fault tolerant. This shall be built in as part of software and hardware at both OCC and at the wayside stations. Fault tolerance is a property of a system that continues operating properly in the event of failure of some of its parts. Fault tolerance can be achieved by anticipating exceptional conditions and building the system to cope with them and in general, aiming for self stabilization so that the system converges towards an error free stage.

4.16 Energy Friendly

The system shall be so designed to ensure maximum power saving in all states of working. It shall be compliant to at least 4 energy stars.

4.17 Bench Marking

The Tenderer is required to give details of benchmarking the software in his offer.

4.18 Man Machine Interface

The interfacing with the terminal operator by the computer system main (server) shall be user friendly and menu driven. In case of vital commands e.g. deletion of user, double checking facility shall be available for doubly ensuring the correctness of command that has been input by the operator. Various help levels shall be available for helping the operator. Tenderer shall give the various levels of help and prompt messages. It shall be possible to select the required option with minimum number of mouse clicks.

4.19 Intensive Operation

The TMS system is intended to be used continuously 24 hours a day. Hence built in features / strategies to ensure that system is available on a continuous basis shall be provided. Particular care in system design shall be taken for those components that have a tendency to fail on rugged usage or whose life is short.

4.20 System Response Time

The system shall be so designed so as to achieve the overall objective of providing instant information for having meaningful action. The following vital response times shall be considered in design.

(i) The response time between a change of state at a wayside station and its display at OCC shall not be greater than 2 Seconds.

(ii) The time taken between initiation of a command for data /result /report and its display on VDU located on OCC LAN shall be as small as possible.

(iii) Specified operating time does not include the operation time of field signalling gears.

4.21 Database Query

It shall be possible to query the database either through format driven commands or by simple parameter related commands. These shall be drawn in consultation with the Engineer.

4.22 System Clock

The system clock shall be synchronized with an extremely accurate external system clock (GPS), which shall drive the entire system. GPS clock shall be provided as a part of Telecom system by ST P-5 Contractor. In case of failure of GPS clock, TMS clock shall keep on working based on last synchronized time.

4.23 Minimum Requirements

The minimum hardware requirements are indicated in the tender documents. If the Tenderer feels that additional hardware is required to achieve the defined objectives, he shall be obliged to supply the same without any additional cost.

4.24 Maintainability

All the equipment shall have LED indications & supported by the specified vendors for diagnostics and assisting maintenance staff in fault finding. The software used shall be structured/modular self-diagnostics type and shall generate alarms in case of any failure.

4.25 Reports

All the reports, their formats, input formats and colour schemes of train graphs etc. shall be finalised in consultation with the Engineer.

4.26 Environmental Specification

All OCC equipment shall be able to withstand following environmental conditions without any degradation in the system performance:

a	Temperature Range :	Under operation: 5 degree Celsius to 35 degree Celsius Under storage: -10 degree Celsius to 60 degree Celsius
b	Humidity:	Up to 95% non-condensing
c	Shock:	15g, 20 msec, ½ Sine
d	Vibrations :	2.0 g Sine from 20 to 2000 Hz Min. 005 G2/Hz from 10 to 2000Hz

All Field equipment except VDUs shall be able to function without any degradation in their performance in the dusty, hot and humid environment as prevalent in the section.

The manufacturer shall indicate the optimum and worst environmental conditions that the equipment is designed for. Any limitation, extent and duration of extreme environment, which the equipment can withstand, shall be clearly indicated.

4.27 Non Compliance

System/Protocols/ Software NOT complying with the above shall be brought out explicitly in the bid.

5. SYSTEM (TECHNICAL) REQUIREMENT SPECIFICATION

The main components of TMS are indicated in the block diagram appended at the end of this Annexure. Broadly, the system will comprise of but not limited to the following:

i) Control office equipment like servers, terminals, LAN, etc.;

ii) Overview mimic indication panel in control office;

iii) Wayside field equipment (ASM terminals, field interfacing unit for interlocking, LC Gates, Porta Huts etc.);

iv) Networking at OCC and in the field;

v) MIS Reports/ alarms generating sub systems;

vi) Drivers for display boards /VDUs at entrances;

vii) Required Software;

viii) Power supply arrangement at OCC & in the field;

ix) Interfacing with GPS clock / Train Radio.

The final hardware configuration of the Application Server, printers and all terminals shall be got agreed by the Engineer.

6. CONTROL OFFICE EQUIPMENT

6.1 Applications/Central Server

Applications server is the main system processor of the TMS for controlling and supervision. It shall have following minimum hardware configuration.

i) Type : High end server

ii) Processor – Minimum 64 Bit, Multi Core Multi processor (Intel Itanium 9300 or better)

iii) Speed - Minimum 2 GHz.

iv) N+1 Hot swap cooling

v) PCI-X 8/16 port Smart Array (P600/P800) Serial Attached SCSI (SAS) controller

vi) Core PCI-X dual port 10/100/1000Base TX LAN (with auto speed sensing; RJ 45 connector, Wake On LAN support)

vii) HDD - Minimum 8X146 GB, Hot swappable, Ultra SCSI in RAID 1.

viii) Blu-ray disc recorder.

ix) Console - 21" colour monitor.

x) Hot swappable redundant power supply.

xi) I/O card - Adequate I/O facility.

xii) Accessories - As required, if any.

xiii) Supporting operating system – 64 bit

xiv) Server shall be mountable on 19" rack.

xv) Three Years warranty (from OEM)

Note: Central Server shall be provided in hot standby mode. The standby server shall be exact replica of Main Server. In the event of problem with main server, execution of application shall be seamlessly transferred to standby server without interrupting the operation and affecting the quality of service of operation. Similarly, if system is running on standby server and it fails, working shall be transferred to main server. Central Server shall be capable enough to deliver the required performance. Tenderer may supply more than one equipment/set of equipment to achieve the required performance along with its hot standby.

6.2 Functions and Facilities of Applications Server

The following shall be the main functions of the applications server.

1) It shall maintain and update in real time the position of all the TMS indications /information over entire Western Corridor / all field nodes to the last second.

2) It shall have all the software loaded and shall provide drive for the Overview mimic indication panel. It shall screen all the incoming information /data and shall revert back to the concerned agency for incomplete information and obtain it in the background.

3) It shall accept input data from the authorized operator / agency / node only. The access to the server shall be through a gateway with proper level of authority. It shall process the data as per requirements of the system.

4) It shall reply to the queries requested by various ASMs in the background without interrupting the section controllers.

5) It shall provide necessary data to print the various reports in suitable formats.

6) It shall enable display of both information and alarms on any of the terminals in OCC, IMDs, stations etc. as per pre - programming.

7) It shall be possible to store at least 30 days TMS data on the main hard disc. Tenderer to give details and archiving system proposed as considered essential.

8) It shall be connected via data channels on DFCCIL's optical fibre link with all the station signal interlockings through a suitable interface. The aggregate information / status of Axle Counter Track sections, signals, points, route set, LC gate closed/open etc. of station and block section on either side shall be transmitted from wayside stations to applications server.

9) Networking with the wayside stations located outside OCC shall be on the DFCCIL's OFC / data channel with 100% redundancy. Vendor can suggest his networking methods between field stations and central server to achieve desired performance. All network elements shall be of managed type.

10) It shall be provided with adequate flexibility so that alterations and additions in the present functions and facilities are carried out with minimum disruption in the working system as and when required. It shall be compatible with future interlocking changes/yard alterations at wayside stations.

11) It shall be compatible for running off line forecasting module for computing expected arrival of trains.

12) Applications server equipment shall be fault tolerant system. It shall also be provided with Disc storage device to store real time database reflecting TMS information as well as an event logging database. Various terminal / equipment in the OCC office shall be interconnected with applications server using a dual local area network (LAN). Adequate redundancy of critical system, software and database shall be ensured.

13) It shall also be able to be set up as any OCC workstation.

14) Any other work to be done by applications server so as to obtain integrated system. Tenderer shall specify this.

6.3 Logging of Data on Servers

1. All the signalling / TMS data / indications shall be logged on the hard disc located on servers designated for this purpose. Data also includes fixed data e.g. Time Table, section layout and signalling scheme, crew booking, loco link details etc.

2. The following data need to be archived for subsequent use: -

   a) All train related on line information. (Signalling indications, train movements details, trains description details etc.)

   b) All system related data viz. node failures, hardware failures, communication failures etc.

   c) All inputs made by the way side terminals (inclusive of ELMD, crew lobby) or by terminals at the OCC.

3. It is preferable to store data in a compressed and organized form so as to conserve the disc space. The Tenderer shall provide details about the compression techniques used.

4. The storage shall be for a minimum period of 30 days.

5. It shall be possible to take INCREMENTAL back up on Blu-ray disc. The Contractor shall provide additional hardware for this purpose.

6. It shall be ensured that the data is not lost while copying.

7. The notes recorded by the section controllers/ASMs shall also be logged.

These notes shall be linked to the concerned screen and context.

6.4 Training Server and Terminals (To be provided by ST P-5 Contractor)

These shall be provided as standalone with its own LAN at the OCC or any other location as decided by the Employer for training and simulation purposes as per

following (but not limited to) details:

1. It shall have the identical configuration of Central Server and facilities as of Central Server. It shall be equipped with the following:

   (i) One terminal for Trainer with 3X21" VDUs;

   (ii) Five terminals for Trainees with 1X21" VDU;

   (iii) Blu-ray Disc player for accessing archived data.

2. It shall be possible to configure Server or Trainer's terminal to work as active section controller's terminal in case of any of the controller's terminal becoming defective / out of service.

3. It shall be possible to configure Server or Trainer's terminal to work as active maintainer's terminal whenever required.

4. It shall be possible to access the database for analysis and simulation studies. The data or results thus generated after simulation study or analysis shall not be stored on the main memory of the Application server permanently. To prevent the same, both hardware and software checks shall be provided. It shall be possible to store it in its own hard disc.

5. For simulation studies, it shall be possible to work on train graphs and time tables interactively but OFF LINE. It shall be possible to alter or generate a new timetable by changing controlling parameters. It shall be possible to obtain past train graphs and schedule train graphs and correlate any of the data on train graphs for deducing results / reasons / solutions.

6. The data generated during the course of simulation shall be temporary.

7. It shall be possible to view the reflected changes made in train graph on the timetable.

8. It shall be possible to simulate a sample dynamic model of the train along with track layout that occupies and releases Axle Counter Track sections.

9. It shall be possible to work trains as per permanent timetable or temporary timetable as desired by proper authority. Timetable Generation and other such applications shall be through this terminal.

10. It shall be possible to have access to main database through Gateway for printing MIS reports or printing data generated at this terminal for analysis or simulation studies.

11. Simulator shall be able to test all commands and indications defined in application data.

    i) Replay a previously recorded traffic situation based on the stored log of events and work on it by changing relevant parameters.

    ii) It shall also simulate train movements by using simplified model of the dynamic properties of the train and the status changes caused in the current traffic by train movements.

iii) Perform simulation studies of traffic considering dynamic parameters like speed limit on signals, other temporary and permanent restrictions, braking characteristics, driver's reaction time etc.

6.5 Chief Controller / Deputy Chief Controller / Section Controller Terminals

A. **Hardware**

Chief Controller / Deputy Chief Controller / Section Controller terminals (work stations) shall have the following **minimum** configuration:-

(1) Type: Workstation (HP z400 or better)
(2) Processor: 64 Bit Intel® Xeon® Six-Core Processor 3.20 GHz or better.
(3) RAM: Minimum 8 GB.
(4) SOLID STATE FLASH DRIVE: Minimum 120 GB
(5) Monitor: 3 nos of 21" colour monitor, high resolution 1920 X1200
(6) I/O card: Adequate I/O facility, Integrated Drive Controllers, Dual network Interface cards, High End Graphics card etc.
(7) Accessories: As required, if any.
(8) Three Years warranty (from OEM)

B. **Facilities**

1. All user initiated functions shall be accessible using Mouse & Key Board.
2. It shall be possible to enter commands through menus, selection in the pictures, functional keys or via text input.
3. All terminals shall be able to see complete yards & block sections of full western corridor.
4. The precise operation of objects and the content menus must be as agreed with the Engineer.
5. All displays shall be active and shall indicate traffic /operator related alarms.
6. It shall be possible to scroll from left to right and vice versa from one station to another without flicker. There shall be full flexibility in regard to display of information on any of 3 video screens.
7. In case of big yards with a number of lines, the yard shall not look congested on the screen and, therefore, predefined scrolling from top to bottom, left to right or vice versa shall be possible. In addition, it shall be possible to divide the bigger yards into suitable no. of pictures.
8. If train identification has not been entered by the train dispatching station, the section controller shall have facility of entering it on getting NDA (Non Description Alarm).
9. It shall be possible to open many windows on each VDU.
10. A window must be active when the cursor is moved in its frame and the operator must be able to issue commands only to those objects in active window.
11. The display shall be dynamic even if the related window on the screen is not active.
12. The various input displays and reporting formats (to be decided in consultation with Engineer) shall be used for dialogue between the operator and the terminal.

13. It shall be possible to view any of the train graphs on controller's terminal be it historical, previous or current.
14. In case of unusual events and delays of trains, system will facilitate the controller to enter the reason and other details in the prescribed formats. This shall form part of database and shall be used for MIS reports later. Alarms shall come along with format for entering the reason.
15. The controller shall be able to enter any inputs regarding rescheduling of trains. This data shall be considered temporary and the operator shall be prompted to input the duration for which the data shall be held valid.
16. The temporary valid data shall be given the same status as that of permanent data and all the time tables and trains graphs shall be generated as per this data.
17. The details of occupancy of berthing lines and sidings shall be available.
18. It shall be possible to view various MIS reports.
19. It shall be possible to mute the audio or change the volume.
20. It shall be possible to alter the viewing angle of the VDU monitor in the vertical and horizontal planes.
21. Current time and date shall be displayed on the VDU screen conspicuously.
22. Multiple operators shall control the system without interfering with each other.
23. Communication arrangements available at stations shall also be displayed symbolically.

C. **Structure of Controller's Video Display**

(i) The controller's display format shall be finalized in consultation with the Engineer.

(ii) Opening screen shall be structured as under: -

1. At the top of window, there must be a top menu showing time, date and alarm indications with predetermined priorities for traffic related alarms. It shall also have menu entry points.
2. An alarm menu window related to area of his jurisdiction with an alarm priority.
3. A dialogue window (it will reflect the commands given).
4. Middle area for application windows.
5. Pop up and pull down menus shall be user friendly.

D. **Operator's Authority**

1. Authority to log in shall be protected through a password. Only authorized persons shall be able to log in and access related database.
2. Where commands are for remote control, checking will be done for each and every command with proper level of authority
3. Access to the server's application software & system software shall be restricted through the gateway and proper authority check.

6.6 Terminals with Other Controllers

These terminals with other controllers shall form part of LAN. These shall include Crew controller, Engineering controller or controller at any other location decided by the Employer.

A. **Hardware**

Other controller terminals (work stations) shall have identical configuration as of Section controller's terminal except that these shall have only one VDU of 21" size.

B. **Facilities**

The following facilities shall be available on these terminals:

1. It shall be possible to gain access to all reports as can be accessed by the section controller.
2. It shall be possible to access the applications server for retrieving reports in suitable format. All the formats for the reports shall be decided in consultation with the Engineer. System will have a provision that a report retrieved by a particular controller pertains to him only.
3. He shall be able to send message to the other controllers through his terminal by video flash /audio buzzer etc.

6.7 Terminal with Signal Fault Controller (To be provided by ST P-5 Contractor)

This terminal shall form part of LAN.

A. **Hardware**

Signal Fault Controller terminal (work station) shall have identical configuration as that of Section controller's terminal.

B. **Facilities**

The following facilities shall be available on this terminal:

1. It shall be possible to gain access to all reports as can be accessed by the section controller
2. It shall be possible to access the applications server for retrieving reports in suitable format. All the formats for the displays /reports shall be decided in consultation with the Engineer. System will have a provision that a report retrieved by him pertains to him only.
3. He shall be able to send message to the other controllers through his terminal by video flash /audio buzzer etc.
4. It shall be possible to see complete yards & block sections of full Western corridor.
5. All displays shall be active and shall indicate signalling /traffic /operator related alarms.
6. It shall be possible to select display of only track layouts or different information on any of 3 video screens.

6.8 Maintainer's Terminal in OCC (To be provided by ST P-5 Contractor)

There will be provision of a fault logging cum diagnostic terminal along with A3 colour

Laser printer in the system. Displays and printouts of equipment faults or communication failure occurring anywhere in control centre equipment shall be readily available on this terminal. In case of faults, the maintainer terminal shall be able to provide all the assistance for rapid detection of faults.

A. **Hardware**

I Maintainer's terminal (work station) shall have identical configuration as that of Section controller's terminal.

II A printer shall be connected for on line logging with the maintenance terminal for logging all network related alarms.

B. **Facilities at Maintainer's Terminal in OCC**

1. The maintainer's terminal shall be used for supervisory functions of the network and for observing any required nodes and their configuration at any time.

2. It shall be used for indication of all alarms, both operators related and network related.

3. It shall be possible to bypass any node if so required.

4. It shall be possible to configure terminals from this terminal.

5. It shall be used to provide fault logging & diagnostics for network equipment at element level.

6. Displays and printouts of equipment faults, communication failure occurring anywhere in the OCC or field network shall be readily available on this terminal.

7. In case of faults, this terminal shall provide all the assistance for rapid detection of faults.

8. Alarms shall be available on this terminal as follows:-

    - Power supply failure at control centre, wayside stations, Auto Location Huts or any node;
    - Air conditioning failure at Porta Cabins in Block Sections.
    - Central control internal communication failure;
    - Communication equipment failure;
    - Field control unit failure;
    - Failure of nodes;
    - ASM terminal failure;
    - System failure;
    - Interlocking interface failure (Field Interface Unit);
    - Any other alarm/ indication considered essential.

    All the above shall be treated as critical alarms.

9. Alarms shall be logged on 'ON LINE 'basis. These shall be recorded in file format so as to access particular file as required at a later date. Exception report (failure report

of desired elements) shall be generated. File format to be decided in consultation with the Engineer.

10. This terminal shall have access to MIS reports.

11. Terminal will provide a pop up window to display a table to allow maintainer to correlate data communication with its associated field objects. Also, on line display about the following shall be available.

    - Station being polled.
    - Station transmitting.
    - Station faulty.

12. Element level Network Management System (NMS) module shall be available on this terminal and shall show:

    i) The position of various nodes;
    ii) Identification of faults and their nature;
    iii) Current status and health of equipment and communication channels;
    iv) Memory utilization;
    v) Remote bypassing and changeover of faulty equipment;
    vi) Ability to check quality of communication from any node to the other on the network including bridges and routers. This shall be done in the background without visibly downgrading the system.
    vii) Facility to view system / network performance statistics on this terminal.

13. FAULT DIAGNOSTICS :

    i) Any malfunction in vital hardware subsystem/modules in the OCC will result in audio & visual alarm at the maintenance terminal.
    ii) The maintenance terminal shall have diagnostic software through which it will periodically scan all elements.
    iii) Diagnostic routine to check hardware like TMS field equipment (excluding interlocking installation) and data communication circuits shall be available.
    iv) Shall have monitor programs to test connectivity.
    v) It shall be possible to switch the transmission lines at all stations.
    vi) It shall be possible to display polling status of stations.
    vii) It shall be possible to capture all transmission events for analysis and fault finding of data transmission.

14. It shall be able to change the password configuration of the controllers /ASMs terminals.

15. It shall allow a fixed data information e.g. Layout, timetable etc. to be keyed in.

C. **Network Management System**

1. NMS facility shall be provided on maintenance terminal by which work station computers, terminal servers, voice and data switching nodes and ASM terminals can

be monitored at element level for performance and switching to back up paths can be carried out.

2. It shall be possible to monitor all elements of network of OCC and field units through NMS.

3. SNMP or standard protocol shall be used.

4. It shall contain real time LAN diagnostics.

5. Facility for Network performance statistics, communication testing and managing internal or external node on the network shall be made available

6.9 Maintainer's Terminal in Signal Equipment Room (All Stations)

There will be provision of a diagnostic terminal in every signal equipment room. It shall be connected on LAN for display of track layout which shall have scrolling facility. In case of faults, the maintainer terminal shall be able to provide all the assistance for rapid detection of faults.

A. **Hardware**

Maintainer's terminal (work station) in Signal Equipment Room shall have identical configuration as that of Section controller's terminal except that it will have only 1 no. of 21" colour monitor.

B. **Facilities at Maintainer's Terminal in Signal Equipment Rooms**

1. The maintainer's terminal shall be used for supervisory functions of the signalling equipment at concerned station and about half block section on either side. However, display for full Block sections shall be available.

2. It shall be used for indication of all alarms for the monitored equipment.

3. It shall be used to provide fault logging & diagnostics for signalling equipment at element level.

4. In case of faults, this terminal shall provide all the assistance for rapid detection of faults.

5. Alarms shall be logged on 'ON LINE 'basis. These shall be recorded in file format so as to access particular file as required at a later date. Exception report (failure report of desired elements) shall be generated. File format to be decided in consultation with the Engineer.

6. Each card status of an equipment rack (e.g. EI, I/O cards) shall be indicated in green for normal and in red for failure. Further details shall be displayed when any card of the equipment on this screen is clicked.

7. It shall be possible to select relays and display its status.

8. All PSS and any other power supply systems shall be monitored.

9. If monitoring of MSDAC can be done on the same terminal, then it shall be incorporated.

10. All signalling drawings of concerned station and adjoining block section shall be loaded on the terminal in pdf format.

11. All manuals pertaining to installed signalling system/sub-system at station and adjoining block sections shall be loaded on the terminal in pdf format.

6.10 Signalling SE/JE's Terminal

One terminal each similar to the ones provided in signal equipment room shall be provided in the office of every sectional Signal SE/JE. It shall have similar facilities of display, diagnostics and loaded documents for the section under jurisdiction of concerned SE/JE.

6.11 Miscellaneous User Terminal

Miscellaneous terminals shall be located at important / relevant offices to have first-hand information about running of trains in visual form and in required format. These terminals shall be either connected directly on LAN or in field network.

HARDWARE

Miscellaneous terminals (work stations) shall have identical configuration as that of Section controller's terminals except that it shall have only one VDU.

FACILITIES: It shall be able to see all the prescribed screens by menu driven commands with mouse.

6.12 General Details

i) All servers and workstations to be provided at OCC shall be of same type and make as approved by the Engineer.
ii) All workstations to be provided at Field Network shall be of same type and make as approved by the Engineer.
iii) All industrial grade PCs to be provided at Field Network shall be of same type of approved make.
iv) All servers, workstations & PC (Terminals) at OCC & Field Network shall be provided with printer slot and minimum 2 spare I/O slots for future use.
v) Vendor of servers, workstations & PC (Terminals) shall have service centres in India.

7. DUAL LAN SYSTEM

7.1 Dual Terminal Server, Dual Communication Server & Other Interface Components

FEATURES

The communication processor to be installed in the OCC shall have the following features: -

i) It shall be dual and fault tolerant.

ii) It shall generate E-1 data streams to be interfaced with one or more DFC's other corridor's data channel cards in the optic fibre cubicle at any of the stations or OCC based on standard non-proprietary protocol with error correcting mechanism.

iii) It shall provide protocol conversion from the LAN to the line protocol.

iv) It shall have adequate storage for buffering to inputs from LAN and for sending data.

v) It shall be based on approved protocol for data circuits.

vi) It shall have a suitable interface for connecting with DFC's other corridor's LAN on Ethernet port with an active Firewall for protection of TMS from Viruses entering from other corridor's side. This port is used only for extracting information from TMS to DFC's other corridors. In addition to this, minimum of two additional Ethernet ports shall be made available for connecting the TMS LAN with other LAN for interoperability among LAN.

vii) Communication processor shall provide full support for the entire protocol stock of the external transmission network.

viii) The communication protocol shall be TCP/IP.

ix) Failure of any single FIU shall not cause failure of complete communication of TMS other than that of particular FIU.

7.2 Transferring Circuits to Backup OFC

It shall be possible to interface and transfer the circuits on to the backup communication on redundant path of OFC, wherever available. The communication processor shall be capable of providing patch up facility.

7.3 Bridges, Gateways, Switches, Repeaters and Routers

1. These components shall be DUAL of approved make using standard protocols. All required networking equipment to be supplied under this item.
2. 30 % spare slots on switches, hubs etc. shall be kept spare for future use.

7.4 Networking / Connectivity in OCC (LAN)

i) The local area network employed shall be Dual LAN Network based on FDDI/Ethernet/Serial communication.

ii) Dual redundant link shall provide highly resilient communications network. System shall be tolerant to multiple simultaneous link failures, maintaining operation without degradation of performance. It shall be possible to perform maintenance on communication links without stopping the signalling system.

iii) Data transfer to peripherals like printers & plotters can be at lower speed for each device using appropriate media with duplicate path.

iv) For connecting peripherals, screened twisted pair cables shall be used.

v) The hubs/switches/network components shall be dual. The connecting cables shall also be dual.

vi) The cables used shall be of rugged type with capability to work data up to at least 100 Mbps.

vii) There shall be facility to add more nodes in OCC and the wiring for additional 4 nodes shall be kept as spare.

viii) The network operating system to be used for this purpose shall be got approved from the Engineer.

ix) The connectivity of the cable with the connector shall be solid without use of any other interface or heat shrink joint.

x) The conductors that make up the pair shall remain as a pair end to end.

7.5 Details of Field Station Network (WAN)

i) All equipment shall be installed in standard 19" racks.

ii) The time slots working shall have redundancy. However, it shall be possible to transfer all data from one time slot to a redundant time slot, if required.

iii) The transmission with field stations shall be controlled by the OCC equipment by polling wherever transmission is in serial mode and not in star configuration.

iv) Full duplex working shall be used.

v) Safety data shall not be in bits but will be in ASCII characters.

vi) In-built safety provisions shall be available to detect data corruption/ non-receipt of packets / node defect problems.

vii) It shall be possible to bypass any station without interrupting the routine working.

7.6 Wiring

i) The wiring shall be protected in PVC casing and capping. Cabling shall be structured one.

ii) All wiring shall be colour coded and shall have tags at the termination points showing the circuit number etc. for easy fault identification.

iii) All wiring at the OCC shall either be concealed or done by internationally accepted wiring procedures and constructs.

8. VIDEO WALL DISPLAY SYSTEM

i) An overview mimic indication panel in the form of a large wall display shall be provided in OCC with track diagrams of all stations/yards and also the Block sections in between the stations to show the complete track layout position / status of points, aspect of signals, level crossing gates, route set indication etc. in real time to provide controllers

with an overview of the complete system.

CT P-14 Contractor shall provide mimic indication panel in the form of a large wall display (composed of no. of cubes) for Dadri - Rewari section (Phase 2) and specifications of the same shall be similar to that proposed/procured by ST P-5 Contractor in Phase 1 and shall be procured from the same vendor in consultation with the Engineer.

ii) Wall display shall include display of SCADA also.

8.1 General Description

i) Display shall be of rear projection type based on single chip DLP Technology. It will consist of Display modules and Display Controller which will integrate various Display modules into a single logical Display Wall.

ii) The wall display shall be made up of individual Rear View projection Display modules which shall be integrated to form a single video wall using Display Control Manager workstation and Video Wall Management Software.

iii) It shall be rugged and of industrial standard and shall be able to work on 24X7 basis.

iv) The display windows shall be freely resizable, rescalable and repositionable on any part of the display wall.

v) Black background shall be used for getting proper contrast. Other colours used shall be such as to give bright and easily distinguishable display.

vi) The Mimic Indication Panel shall display all Axle Counter Track sectioned lines and all interlocked signal aspects of track layouts of stations & block sections.

vii) Station codes, signals, tracks, train description etc. shall be displayed. The field objects shall be as per geographical layout. For trains, however, the train IDs only may be displayed.

viii) Sufficient space shall be made available between the track indications for alphanumeric displays.

ix) The Overview Mimic Indication Panel, in addition to display of important indications, will also provide alarm indications of failure of points, signals, Axle Counter Track sections etc., as the case may be. Less significant objects/indications like non Axle Counter Track sectioned sidings etc. will be shown with a thick line of suitable colour on the overview panel.

x) The Overview Mimic Indication Panel unit shall display the occupancy of various track sections along with the train description. Train ID box shall indicate different colours for different type of loads e.g. Container, Petroleum products, Food grains etc. In case train number is not keyed-in, the same shall be shown as flashing unknown train identifier mark along with Non Described Alarm (NDA). Alarm will stop as soon as the train number is keyed in by the controller / wayside ASM.

xi) If a train has stopped at any location enroute for more than the prescribed minutes, an alarm shall be raised to draw attention of the controller.

xii) It shall be possible to update changes in yard layout through software from the maintenance terminals without any requirement of change in the hardware. The uploading time of software changes shall be minimum and it shall be possible without complete shutdown of the indication system.

xiii) It shall be possible to show the temporary speed restrictions by showing the Tag box or by any other means.

xiv) Suitable Interface equipment and drivers for linking indication panel with applications server shall be provided.

xv) The terminal server /driver for driving the overview mimic indication panel shall have full-fledged capacity to drive described displays from provided equipment + 20% spare.

xvi) The overview mimic indication panel shall be vertical and placed in an arc shape mode so that all the parts of the panel are seen clearly with ease without strain when seen by Section Controllers and Chief Controller from their farthest seats.

xvii) Legibility, lighting, contrast, content, font size, viewing distance etc. shall be kept in view while designing graphics for the display.

xviii) Surface shall have matt finish to keep it glare free.

xix) Glass backing shall be used so that there is no screen build bulge in.

xx) Station layouts can be arranged in a number of rows – top, middle and bottom.

xxi) The lowest row shall not be below 1.5 meters (approx.) from the floor to ensure proper viewing angle. This shall be got agreed by the Engineer.

xxii) Pedestal shall be made of Aluminium extruded and anodized members.

xxiii) Front of the pedestal shall be covered.

xxiv) Sufficient space shall be made available between the track indications for alphanumeric displays.

xxv) It shall be compatible with the international VIDEO Standards.

xxvi) It shall have high MTBF and low MTTR. Values of the same shall be given with supporting calculations/data.

xxvii) Rear Projection System shall have rear service access.

xxviii) Projection system will have cooling fan with dust filter.

xxix) NOT USED.

xxx) It shall be possible to increase/decrease the colour intensity, contrast adjusting etc. screen wise through the system console. It shall be possible to memorize the parameters of one screen and use the same parameters for all the other screens.

xxxi) The unit shall be compact and energy efficient so as to conserve on space and power consumption.

xxxii) The Tenderer shall give entire projector support software packages, documentation and details of maintenance.

xxxiii) All kits required for achieving the above shall form an integral part of the system.

xxxiv) Any other facility to make the system more user friendly shall be incorporated by the Tenderer.

xxxv) Indigenous service support shall be available for the chosen make.

8.2 Minimum technical Requirements of Display Wall

Item	**Specification**
Projection Technology	Display Unit/Rear Projection Module must be based on Single Chip DLP-based Rear Projection Technology.
Architecture	The display unit/rear projection modules shall have in-built illumination system.
Display size	The diagonal size of each visual display unit/rear projection module shall be Minimum 70 inch Diagonal (to be got agreed by the Engineer).
Resolution	Each individual cube minimum Full HD (1920x1080 pixels).
Aspect Ratio	16:10 or 16:9
Lamp type	LED - RGB (1 each of about 12 sq. mm surface area). Multiple LEDs of each colour to achieve this surface area not acceptable.
Display redundancy	In case of failure of any 1 or 2 LED lamps, it shall be possible to display the Image with balance 2 or 1 LED lamps to continue the display and automatically switch the original display colour into other available colours.
	Error shall also be shown by Diagnostic LED indicators in case of LED lamp failure.
Cooling Mechanism	Cooling shall be by means of heat pipe. No pump based mechanism is acceptable due to possibility of failure.
Brightness	Shall be minimum 700 lumens.
Brightness Uniformity	≥ 95%. To automatically provide brightness and colour stability over time and across the entire display.
Contrast ratio (Full field)	≥ 1400:1
Colour gamut	Better than 100% EBU.
Screen	Burn free. No memory and no ghosting. No constant flicker. Low reflection with matt finish.
Screen type	Fresnel/ Lenticular/ Black Bead /Cross Prism (XPS).
Screen to screen gap	Shall be adjustable up to 1.0 mm or less for seamless viewing.
Viewing Angle	Full viewing angle shall be 180 degrees.
Half Gain Angle	Horizontal: ± 35 degrees.
	Vertical: ±33 degrees.
Pedestals	Shall be customized as per project requirements.
Input terminals	5x RGBHV on BNC
	HD-15
	2x DVI-D
	Component video BNCx3(Y/Pb/Pr, Share with Analog RGB BNC)
	RS232C
	RS422 RJ45
Output terminals	1xRS422 RJ45
	1xDigital DVI-D

Item	Specification
Inputs (Additional)	System shall have the following additional inputs ports:
	5x RGBHV on BNC
	HD-15
	2x DVI-D
	CVBS Video BNC
	Component video BNCx3(Y/Pb/Pr, Share with Analogue RGB BNC)
Component input Compatibility	480i, 480P, 720P, 1080i, 1080P
Video Compatibility (CVBS)	NTSC3.58/NTSC4.43, PAL, SECAM
Auto detection	System shall automatically search the source which has input signal after signal plug- in.
Source Redundancy	System shall be able to switch to secondary DVI input if primary DVI input is not available.
	System shall also automatically switch back to primary DVI from secondary DVI input as soon as primary DVI input becomes available again.
Video feature	10 bit motion adaptive de interlacing for HD and SD
	Detail enhancement (H, V peaking).
	Adaptive detail enhancement featuring sharpness and texture enhancement (STE).
	Enhanced noise reduction with Mosquito noise reduction (MNR) and Block Artifact Reduction (BAR).
High Resolution Inputs	Shall accept QXGA inputs directly into the cube.
Power control:	1 AC power ON/OFF switch
wire control:	RS232C/ RS422 input
LED indicator	Power LED (Standby: Red, On: Green), Fan LED, Lamp LED.
On Screen Display	Input selection, Picture, Image, tilling shall be adjusted by On Screen Display.
	Warping - Barrel, Pincushion and keystone.
	Edge Blending.
	In case of any failure in projection module, system shall be able to generate 2 levels of Alarms on wall: Yellow level: Warning Red level: Critical
OSD Languages	English
IP /Remote Control	User should be able to control and monitor each Projection module through Internet / Intranet.
AC Power Input Range	90~240VAC, 50 +/- 3Hz.
Component Life-LEDs	>60,000 Hours
LED Control	Dynamic control
Start up	Instant hot restart
Operating Temperature	5ºC to 35ºC.
Storage Temperature	-10°C to +60°C
Operating Relative Humidity	Maximum 95% non-condensing.

Item	Specification
Component life - DMD Panel	Shall be greater than 650,000 Hrs.

8.3 Display Wall Controller

i) It shall be of Industrial Grade.

ii) It shall provide control over data and graphics suitable for 24 X 7 operation capable of driving demanding high resolution tiled wall display.

iii) It shall include fully integrated user friendly display wall management software.

iv) It shall have fault resilient modular architecture for easy expandability.

v) Wall Manager Software: It shall be possible to create, edit and save display layout to be projected on screen through wall controller and be launched on screen as per requirement. Simultaneous multi display system along with layout editor is required.

8.4 Minimum technical Requirements of Display Wall Controller

Group	Specification Item
Features	• Robust processing platform • Redundant, hot-swappable hard drives, cooling fans and power supplies • Built for high performance • High-performance input and output hardware processing technologies • PCI Express switch fabric • To support Minimum of 64 display outputs, 128 video inputs and 48 RGB/DVI/Component inputs • Exclusive easy-to-use wall-management software
Processor	4/8 Core Intel® Xeon 64-bit 2.0 GHz CPU or better
RAM Capacity	* 18x 240-pin DIMM sockets
	Min 4GB and Shall be upgradable up to 192 GB 1333 / 1066 / 800MHz DDR3 ECC Registered memory
Expansion Slots	7 slots PCI-E 3.0
HDD	Minimum 1 TB Hard Disk.
	Support for up to minimum 6 Hard disks shall be available.
	Hard disk Capacity shall be upgradable.
RAID	* RAID 0, 1, 5, 10 support (Windows).
Networking	* Dual-port Gigabit Ethernet Controller inbuilt.
	* Support for Add on Network adapters.
	* Support for Optical Fibre interface Adapters.
OS	*Shall support 64-bit Operating System
Power Supply	* 800W (1 + 1) Redundant AC-DC high-efficiency power supply w/ PFC
	* AC Voltage 100 - 240V, 50 +/- 3Hz
Chassis	* 19” industrial Rack mount movable

Group	Specification Item
	Front Panel shall have lockable Door to Protect Drives.
System Reliability	* Operating Temperature: 10° to 35°C
	* Storage Temperature: -40° to 70°C
	* Humidity: Up to 90% non-condensing
System Cooling	* 3x 5000 RPM Hot-swap PWM Cooling Fans
	* 2x 5000 RPM Hot-swap Rear Exhaust PWM fans
Composite video inputs **type/formats** • NTSC M, NTSC J, NTSC N, NTSC 4.43 50/60, PAL I, PAL B, PAL D, PAL G, PAL H, PAL M, PAL N, PAL NC, PAL4.43 60, SECAM B, SECAM D, SECAM G, SECAM K, SECAM L, SECAM LD **frame (refresh) rate** • 30 fps (NTSC) • 25 fps (PAL) **video inputs/system** • 128 (simultaneous) **advanced processing** • 3D comb filtering with advanced processing	
RGB/DVI input expansion **number of input sources per system**• 48 **analog input connection type** • DVI-I (comes with VGA adapter) **digital (DVI) input connection type** • DVI-I **analog resolution/source** • 2048 x 1536 **digital resolution/source** • 2560 x 1600 (with optional DL-DVI input board) **support for non-interlaced sources** • Yes **form factor** • 64 bit	
Display outputs **number of display channels** • 64 **resolution/channel (analog)** • 2048 x 1536 @ 60Hz **resolution/channel (digital)** • minimum 1920 x 1080 @ 60Hz **graphics memory** • minimum 512MB per card	
Redundancy Support	**System Shall have the redundancy support for following:**
	Controller
	Controller Hard Disk Data
	Power Supply
	LAN
	Cooling FAN
	Scenarios
Warranty	Three Years warranty (from OEM)

8.5 Technical Requirements of Wall Management Software

Client & Server based Architecture	Shall support Multi client/Console control for the Wall layouts.
Scaling and display	Software shall enable user to display multiple sources up to any size and anywhere on the display wall.
Controls	Software shall support control of Brightness, Contrast, Saturation, Hue, filtering, Crop and Rotate function as per user requirement.
RS232, TCP/IP	RS232 & TCP/IP support shall be available for other interfaces.
Remote Control	Control of wall from Remote PC through LAN shall be possible.

Auto Source Detection	Software shall support auto source detection.
Layout Management	Shall support for Video, RGB, DVI, Internet Explorer, Desktop Application and Remote Desktop Monitoring Layouts.
Scenarios	Software shall be able to save and load desktop layouts from Local or remote machines.
Layout Scheduler	Shall be possible to schedule all the layouts as per user convenience.
	Software shall support auto launch of layouts according to specified time event by user.
Launch Application	Software shall be able to support.
User friendly	Software shall be user friendly.
Protocol	VNC(Virtual Network Connection)
Interface	LAN
Scaling and display	Display of multiple sources up to any size anywhere on the wall shall be possible.
Console View	**Software shall enable user to select following views:**
	Primary Display
	Secondary Display
	Full Desktop
	Selected region
	Selected application
KVM Support	Keyboard, Mouse Control.
	Enable/Disable Keyboards and Mouse Controls.
Short cut Keys	Shall support.
Control operator workstations	Software shall be able to Support.
Multiple concurrent client users	Software shall be able to Support.

9. POWER SUPPLY ARRANGEMENT

9.1 Load of TMS

Load of TMS shall be combined with other Signal & Telecom equipment loads in OCC as well as at stations and combined PSS provided by ST P-5 Contractor as per details given in bid documents. Capacity of PSS in OCC shall be determined by taking load requirement of Dadri – Rewari section of Phase 2 TMS also and calculations got agreed by the Engineer.

9.2 Earthing of Equipment

i) The Contractor shall make suitable arrangements to earth all equipment at all locations including OCC, stations, lobbies etc. for EMC/EMI protection.

ii) Earthing design shall be got approved by the Engineer.

iii) Earthing shall be maintenance free.

iv) Earthing value shall not exceed 1 Ohm.

10. WAYSIDE STATION EQUIPMENT

10.1 General

i) At wayside stations, following equipment / units shall be installed.

a) LINE INTERFACING UNIT (LIU): This is the front-end unit that will interface with the field units (FIUs), ASM terminals, VDUs etc. at one end with data cable at the other end for transmitting / receiving information in the required format. Data cable is connected at the far end to optical interface card located in optic fibre cubicle.

b) FIELD INTERFACING UNIT (FIU): This unit will interface with the potential free contacts in Signal Equipment room and extend data to / from Electronic interlocking.

c) ASM TERMINALS: These are for inputting data /querying functions and are Work Station terminals.The hardware installed at stations shall be modular and rugged.

ii) The modules to be provided at various ASM Locations shall be identical.

iii) The protocol and design of the modules supplied for accessing the TMS information shall be based on internationally approved standards and the Tenderer shall give the details of the same in his offer.

iv) LED Indications and test points shall be available on various cards /Modules for easy fault diagnostics by the Maintenance personnel.

v) Field station hardware shall be housed in a 19" dust free, pre-wired rack. It shall be on Modular Computing Platform using 30 micron gold plating on slot connectors, Keyboards protected with protective membrane to avoid dust ingress, Front panel I/O access & direct PLC type wiring.

10.2 Field Interfacing Unit (FIU) or PLC for Data Acquisition

i) Field Interfacing Unit shall consist of - Modem for communication, Processor card, Power supply card, Interface to connect ASM PC, Required numbers of I/O cards, Required number of 19" rack/cabinet etc.

ii) The field interfacing units shall acquire aggregated data from Signal Equipment room and transmit the same to communication network using standard protocol.

iii) These units shall be installed in Signal Equipment room in a stand-alone mode. 20 % of the slots used for fixing I/O and peripheral cards shall be kept spare for future expansion.

10.3 Auto Route Setting

This facility shall be provided in future along with CTC.

10.4 ASM's Graphic Terminals

A. **Hardware**

ASM's Graphic terminals (work station) shall have identical configuration as that of Section controller's terminal.

B. **Facilities**

1. All user initiated functions shall be accessible using Mouse & Key Board.

2. It shall be possible to enter commands through menus, selection in the pictures, functional keys or via text input.

3. All terminals shall be able to display complete yard controlled by concerned ASM & full block sections on either side of controlled station.

4. There shall be on line display of train movements (including description) along with layout and status of signalling.

5. The precise operation of objects and the content menus must be as agreed with the Engineer.

6. All displays shall be active and shall indicate traffic /operator related alarms.

7. It shall be possible to scroll from left to right and vice versa without flicker. There shall be full flexibility in regard to display of information on any of 3 video screens.

8. In case of big yards with a number of lines, the yard shall not look congested on the screen and, therefore, predefined scrolling from top to bottom, left to right or vice versa shall be possible. In addition, it shall be possible to divide the bigger yards into suitable no. of pictures.

9. It shall be possible to enter train numbers for the train to be dispatched and entered train number shall be sent to central server.

10. There shall be two sub-menu items for the dispatch option of the main menu

    (i) Scheduled Dispatch – To dispatch a scheduled train.
    (ii) Special Dispatch – To dispatch a special train.

11. For scheduled dispatch, the window shall list pre-stored train numbers along with scheduled time of departure and destination station from timetable stored in Central Server. The ASM shall modify the departure time, destination if required. This shall be menu driven. The scheme for the menu driven commands shall be drawn in consultation with the Engineer.

12. The window for dispatching special train shall have the following:
    - Train Number
    - Time of Departure
    - Load Type (container/food grain/POL/Light engine etc.)
    - Destination

13. It shall be possible to input TRAIN ID (up to 8 digits) along with other details such as special information about load, crew etc. These details normally shall be flashed by system automatically on departing station's ASM's screen as per schedule. If train

identification has not been entered by the train dispatching station, NDA (Non Description Alarm) shall be initiated as soon as departure signal for the said train is taken off.

14. It shall be possible to query the Central Server in either formal menu driven commands or with simple parameter related command.

15. It shall be possible to get information of train position from central server. On selection of this menu, user shall be asked to select/enter the train number. The system would then display train position, crew name, Load type etc.

16. It shall be possible to open many windows on each VDU.

17. A window must be active when the cursor is moved in its frame and the ASM must be able to issue commands only to those objects in active window.

18. The display shall be dynamic even if the related window on the screen is not active.

19. The various input displays and reporting formats (to be decided in consultation with the Engineer) shall be used for dialogue between the operator and the terminal.

20. In case of unusual events and delays of trains, system will facilitate the ASM to enter the reason and other details in the prescribed formats. This shall form part of database and shall be used for MIS reports later. Alarm shall come along with format for entering the reason.

21. The temporary valid data shall be given the same status as that of permanent data and all the time tables and train graphs shall be generated as per this data.

22. The details of occupancy of berthing lines and sidings shall be available.

23. It shall be possible to view various MIS reports.
24. It shall be possible to mute the audio or change the volume.

25. It shall be possible to alter the viewing angle of the VDU monitor in the vertical and horizontal planes.

26. Current time and date shall be displayed on the VDU screen conspicuously.

27. Communication arrangements available at the station shall also be displayed symbolically.

28. Details of loads available on sidings at concerned station shall be displayed when cursor is placed on the siding.

29. Whenever a train / load leaves /enters the control area of concerned station or is put out of the system by placing it in the siding or sending it to ELMD, the ASM shall have facility to delete / enter such trains from / into the system.

30. Flashing message / instructions from the controller and information about expected arrival of next two trains on each line, cancellation and diversion of trains shall be displayed.

31. It shall be possible to send messages to central server. On selection of this menu, user shall be asked to select a pre-stored message, which shall then be sent to central server.

32. It shall also be possible to send any message, which is not pre-stored in ASM terminal. On selection of this menu, user shall be prompted to enter his message in a dialogue window, which then shall be forwarded to central server.

33. It shall be possible to test connectivity to Field Interface Units.

34. The system shall be able to rename a train standing on the current system.

35. It shall be possible to send message from TMS controller to ASM PC.

36. The system shall keep log of all the messages received from TMS.

10.5 Terminals with ELMD & Lobbies

Terminals on the field network shall be provided at the designated locations that control the locos, crew booking and management.

These terminals shall have access to Loco controller whose terminal will have data for loco link modules, Loco maintenance schedule link, crew links and other related modules.

i) HARDWARE – Latest Industrial grade embedded fan less PC

a) Chassis: Industrial grade rack mountable 19", 4U
b) Slots: 14 slots supporting minimum 12 ISA/PCI slots and 2 CPU slots
c) NOT USED.
d) Processor: Minimum Pentium IV, Minimum 1.8 GHz.
e) Cache: Minimum 512 KB
f) RAM: Minimum 1GB.
g) SOLID STATE FLASH DRIVE: Minimum 120 GB
h) Monitor: 21" colour VDU monitor
i) I/O card: Adequate I/O facility, Controllers, network interface etc.
j) Accessories: As required, if any.
k) Environment: Operating temp = 0-55°C

ii) FACILITIES WITH TERMINALS IN LOBBY

a) ON Line position of Crew with details of train and location.

b) It shall be possible to change the names of Crew when prompted to do so by the Central Server.

c) Daily print outs for planned (through) bookings and actual (through) bookings shall be possible.

d) Monthly reports of Crew in terms of Kms. and Duty Hours (individual date wise) shall be possible.

e) Screen shall be menu driven with multiple windows.

f) ON Line position of train positioning shall be available on request.

g) The screens and the procedures shall be decided in consultation with the Engineer.

h) It shall be possible to input Crew Booking details for next 24 Hours.

i) At lobbies, normally the nomination of train wise Crew is decided in advance for the next twenty-four hours. It shall be possible to input information in advance, which shall be used at the appropriate time as per the timetable. Hence, normally when the system/ASM inputs a train number for the next departing train, the OCC shall link this information already input by the lobby and shall flash complete details on the screen at the lobby terminal. The lobby operator shall be able to change the data in case of any amendments. In case of no change, the displayed data shall be assumed correct.

iii) FACILITIES WITH TERMINALS AT ELMD (To be provided by ST P-5 Contractor).

a) ON Line position of locos available at various sidings (station wise) shall be available.

b) ON line position of locos in service at a particular time with train number and location details shall be available.

c) ON Line position of loco movements earmarked for sending to ELMD shall be available. Details of locos earmarked for sending to ELMD shall be entered by Loco Controller.

d) It shall be possible to query the Central Server at OCC

e) It shall be able to generate reports on crew links, loco links, utilization of locos, crews and other related MIS reports. Formats of inputting information and reports shall be finalized in consultation with the Engineer.

f) The screen shall be menu driven with multiple windows.

g) It shall have a facility to view ON Line position of locos along with ON Line position of crew available on each train. These terminals shall have access to the database dealing with loco links and crew links and other related MIS reports.

h) It shall be possible to send weekly schedule of Loco attachment/ detachment from ELMD to OCC for its integration with the time table.

10.6 Wiring

i) The wiring shall be protected in PVC casing and capping. Cabling shall be structured one.

ii) Where cables/wires are run under false floor, these will be supported on and tied to perforated cable trays.

iii) All wiring shall be colour coded and shall have tags at the termination points showing the circuit number etc. for easy fault identification.

11. SOFTWARE

11.1 General

All desired features of application software are described in FRS. This shall be referred while designing software.

i) All software shall be based on open system concept, shall be modular and independent of type of processor or hardware platform.

ii) It shall be based on co-operative or client server processing architecture with distributed processing logic.

iii) It shall be 64 bit UNIX or Multitasking for OCC & suitable 64 bit operating system for field network and ORACLE /SQL/DB2 for database.

iv) Security: The Tenderer shall define the procedures to maintain the security of the system software. Aspects to be considered are:

a) Sabotage – The Tenderer shall describe what measures shall be taken to protect the software against sabotage. This description shall define the physical restrictions as well as procedural measures and specific tests to be carried on the software.

b) Unauthorized Access: The Tenderer shall describe what measures are to be taken to protect the software against unauthorized access and subsequent modification. The description shall define physical & procedural methods.

c) VIRUS: The Tenderer shall ensure that software which is susceptible to virus is developed in environment certified free from computer viruses. To achieve this, the Tenderer shall use proprietary virus detection and suppression tools as approved by the Engineer.

v) It shall be menu driven & modular system.

vi) All software shall be portable across similar operating systems.

vii) The real time DBMS used for linking clients and servers shall keep at least two synchronized copies of all data bases to enable quick switch over to standby processes without loss of data (RAID 1 System). To achieve hardware tolerance at the main server, the disc controllers used for RAID systems shall be separate.

viii) It shall be possible to access the same file by more than two users at the same time and information on such a file shall be active.

ix) The database shall be stored in file structure for easy retrieval of the selected data.

ix) It shall be possible to add minor additional functionality (in consultation with the Engineer) or even extend the system to more number of users by adding extra workstations without changing existing software.

x) The modification /alteration shall be possible from the simulation terminal without any reference to source code. Menu driven tools shall be made available. To ensure that alterations /amendments are carried out as intended, the terminal operator shall confirm the amendments before inputting to system or saving on system. System shall prompt confirmation request with authority. All amendments shall be recorded with the authority.

xi) As all data may not be available in a satisfactory format during the initial implementation of the system, it is necessary that provision exists for incorporating changes/amendments to the existing formats/presentation and for introduction of new functionality. It is possible that additional items/objects may have to be introduced in future.

xii) Following modifications shall be possible without recourse to the source program (code).

a) MANAGING THE USERS

- Ability to add users specifying their names, password & access level.
- Facility to delete an existing user.
- Change the priorities allocated to users.
- Stop / provide access to any of the modules.
- Change areas of jurisdiction.

b) DATABASE MANAGEMENT

- Database administration
- Edit database to change the names of locations, stations etc.
- Change status of stations.
- Introduce new stations.
- Introduce new objects and delete existing objects.
- Change details of objects.
- Amend / alter geographical layout at stations and in between stations.
- Change format of reports.
- Introduce new reports.
- Introduce/change/delete temporary speed restrictions.

c) TIME TABLE MANAGEMENT:

- Cancel a train trip;
- Insert an additional train trip;
- Change the destination of a trip;
- Change the departure time of a trip; and
- Change the timetabled dwell time at any station for one Train or all Trains.
- Change timings of existing trains.
- Change the sequences of trains.
- Change various particulars of trains.
- Change the loco number vis-à-vis train number.

d) SYSTEM MANAGEMENT:

- Change priorities of existing alarms.
- Introduce new alarms with varying priorities.
- Changing the details of any node.
- Introduction of new nodes.
- Changing the displays on maintainer's terminal.
- Changing the printer / plotter parameters.

e) TRAIN GRAPH DISPLAY

- Create, modify, and delete controlled area included in the train graph display.
- Change the various colours allocated for various types of train loads.
- Change x & y coordinate scales.

xiii) Suitable protection against VIRUS shall be provided. Any bug found in the software during or after DLP shall be eliminated free of cost.

xiv) Detailed documentation of application software shall be supplied.

xv) All standard software supplied shall be licensed versions in the name of "DFCCIL" along with original latest documentation.

xvi) All software for driving the overview mimic indication panel shall also be included.

xvii) The software code details of Modules explicitly developed for DFCCIL shall be supplied along with full documentation. Details of each module shall be explained.

xviii) OPEN CHARACTER: The application software shall be standard open in character and shall be able to run in multi-vendor environments.

xix) COMPLETENESS OF INFORMATION: No information shall be transmitted unless all the information is entered or the operator has declared that he has input all the required information.

11.2 Event Log and Alarm System

i) All important events (commands, indications, errors, system information etc.) shall be logged in a log SQL database for printing and analysis later on.

ii) Log database shall be separated into 3 sections viz. system log, short term log & long term log. The time span of log depends on the size of database and intensity of log events.

iii) Replay of Event log: The replay function shall show an historical flow of events that has occurred and recorded earlier in the TMS system, e.g. in connection with an accident or a fault.

iv) When replay shall be started, the dynamic status for infrastructure, train number system pre-test and alarm list as well as the pictures on the screen shall be initialized.

v) TRAFFIC RELATED ALARMS: Vital traffic operator related alarms are:

a) Failure of any signalling gear in the entire section.

b) Route/(s) not released after passage of train.

c) Train not described alarm (ND Alarm).

d) If a train stands at an OFF signal for more than 2 minutes, it shall initiate an alarm. Any other unscheduled train stoppage shall also initiate an alarm.

e) Any unscheduled train detention in excess of 5 minutes time shall also initiate an alarm.

f) Hot Axle detector alarm (to be actuated from potential free contacts of relays provided by PE-6 Contractor in SERs/OCC).

User shall be able to select setting of time elapse (1-10 minutes) before actuation of alarm in items “d” and “e” above.

vi) NETWORK RELATED ALARMS

a) All alarms not directly related to traffic operations shall be considered to be Network related alarms.

b) These shall be displayed on the maintainer’s terminal only on which NMS is loaded.

c) These shall be arranged in priority levels in consultation with the Engineer.

d) Failure of Network Communication / inability to access any of the nodes, defective terminals, hardware and software failures shall be flashed.

11.3 Software - Train Describer System

i) All desired features of application software are described in FRS. This shall be referred while designing software.

ii) The train describer system shall enable controllers to identify any train by means of unique number allocated to each train. The number shall follow a train automatically as it moves through the DFCCIL network.

iii) The Train Nos. shall be displayed at their positions and shown on monitors and overview indication panels in control office.

iv) The train description shall be entered either by an ASM at the originating station or an controller in the control office.

v) Train Describer system shall also direct all traffic related alarms to respective controllers e.g. Signal failures to Signal Fault Controller, Track failures to Engineering Controller, Loco failures to Loco controller.

11.4 Software - Customization Tool

i) The tool shall allow user to cater for changes in yard layout and to carry out the required changes in databases and graphic display of altered layout.

ii) The tool shall facilitate user to generate new report from the available database.

11.5 Software - MIS Report Generation

i) The system shall allow user to enter any free text tag to be associated with any train.

ii) The system shall generate report for trains run late by prescribed reference.

iii) Based on the events logged and the controller input, the system shall generate following reports:

a. Various Train control charts

b. Various Punctuality reports

c. Bad runner report
d. Actual Loco Link Report
e. Load Composition report
f. Loco Maintenance/overhauling reports.
g. Punctuality analysis report in suitable format. This may be daily, weekly or monthly as per prescribed format.
h. Analytical report of various unusual occurrences, i.e. signal failures, OHE break down, loco failure etc. This shall be generated on daily, weekly or monthly basis on prescribed format.
i. Analytical report of crew link/ utilization.
j. Analytical report on loco link/ utilization.
k. Total Combined Maintenance Blocks granted / refused along with locations, time blocked, time cleared.
l. Sectional running time taken by train of any ID.
m. Report of trains run late along with train nos., delayed time (at stations) etc.
n. Difference between actual and scheduled running time in tabulated as well as in graphical form

11.6 Software- Train Graph

i) The system shall plot historical train graphs for analysis.
ii) It shall plot time on X axis and stations on Y axis.
iii) It shall be possible to show schedule time and the actual time in the same graph but with different colors.
iv) It shall be possible to show different types of train loads in different colors.
v) It shall be possible to select direction of train and day for which graph is to be plotted.
vi) On clicking / selecting a particular train graph, it shall give complete information about the train details viz. train no, crew information, loco, load details etc.
vii) Advance charting: In case controller defines the Combined Maintenance Block on particular line for particular time, system shall be able to prepare train graph showing advance/predictive movements of available trains in particular section in different colours.
viii) It shall be possible to deduce average speed of trains between any two stations.

11.7 Interactive Train Graph (Off Line)

i) To plot the modified train graph in case of rescheduling of trains.
ii) To alter the running time of any train interactively (pull or drag) to see the effect INSTANTLY. It shall be possible to see the effects of increase / decrease in running time on the train graphs.
iii) To find out the effect of speed restrictions, increase in train speed, modification in the station stopping time, effect of a failure at a given station etc.

iv) It shall be possible to deduce average speed of trains between any two stations.

11.8 Simulation Studies Including Timetable Planning System (Off Line)

i) Separate terminal shall be provided (By ST P-5 Contractor) for simulation studies & Timetable Planning System purpose. The replay of log, time table editing, editing of train graph etc. shall be provided on this terminal.

ii) It shall be possible to simulate and observe the effect of various parameters such as Maintenance block, Speed restrictions, Change in yard layouts etc. on sectional density (capacity) and to produce train graphs in pictorial or tabular form. Simulation of the effect of addition / deletion of a signal shall also be possible. The parameters shall be decided in consultation with the Engineer.

iii) Simulation of train movements: Train movement shall be simulated by occupying & releasing Axle Counter Track sections on sections in accordance with movement of trains. The replay of log with predefined begin & end time shall be possible.

iv) The simulator shall work with the same data as the on line system or separate Master data can be kept on the system

v) It shall be possible to carry out simulation in real time or in reduced / accelerated time scale.

vi) Automatic recording and retrieval of train movements shall be possible.

vii) The system shall be capable of simulating the existing time-table and compare it with actual running on periodic basis to create Management Information to identify any shortcomings in the system / time-table.

viii) Time table compilation and Proving: A time table compilation and proving system shall be provided such that time tables can be compiled and tested off line and loaded directly to the System when ready.

ix) The time table compilation and proving system shall enable the creation and modification of time tables through Simulation terminal.

x) Modification of an active timetable shall be possible and such modifications shall take immediate effect.

xi) Time table modifications shall remain effective until cancelled or until the end of the operating day, whichever is sooner. The modified timetable shall be saved separately from the reference timetable for future use and the reference timetable shall not be permanently changed by changes made in the above manner.

xii) Time table Editor: The time table compilation and proving system shall provide an editor for editing inter station running times, station dwell times, terminus turnaround times and train description for each of the time table blocks (timetable periods) defined.

xiii) Types of Trains in Time table: It will be suitable for all types of trains working on DFCCIL line.

xiv) Generation of time table: The time table compilation and proving system shall generate the following different parts of the time tables;

a) Working time table;

b) Distances between stations and different sets of run time and dwell times;

c) Summary of train frequencies.

xv) Plot Train Movements: The time table compilation and proving system shall plot train movements in the form of a time distance graph utilising a suitable colour scheme on A0 size graph as approved by the Engineer.

xvi) Generate summary information: The time table compilation and proving system shall calculate and generate number of train trips and train kilometres for all time table trains.

11.9 Software- Crew Management System (Off line)

i) Crew management software system shall be provided for Loco Pilots of DFCCIL line.

ii) Crew management details shall be fed by lobby staff separately for each Loco Pilot. The database will have all the information related to personnel & safety of Loco Pilots.

iii) Software will prepare detailed link program based on data fed by lobby staff for Loco Pilots.

iv) It shall be possible to change Loco Pilots booking details for next 24 Hrs.

v) Daily report of planned booking and actual booking of crew shall be possible.

vi) Monthly reports of Loco Pilots in terms of KMs & duty hours, individual date wise shall be possible based on real time data from TMS.

vii) It shall be possible to calculate running allowance of crew based on real time data from TMS.

11.10 Software – Automatic Route Setting (ARS)

System shall be capable for its provision in future.

11.11 Stages of Development of Software

11.11.1 **Level of Bugs**

Bugs found during various stages of software development shall be categorized as under:

Blocker: Block Development and/or testing work.
Critical: Crashes, loss of data, severe memory leak etc.
Major: Major loss of function.
Minor: Minor loss of function or other problem where easy workaround is present.
Trivial: Cosmetic Problem like misspelled words or misaligned text.
Enhancement: Request for enhancement.

11.11.2 **Software development stages:**

i) Story Boarding Stage: This delivery consists of submission of design documents in the form of storytelling. Document indicates various screens, transactions, queries and

reports. Story boarding is intended to provide an early preview to the application and its sequential development. It would give an insight into navigational structure, look and feel of module. The story boarding document is to be approved by a committee of Engineer in charge, User and contractor. User can give large amount of inputs for improvement of the interfaces at this stage. All such improvements are to be incorporated in design document.

ii) Alpha Stage: This stage pertains to development of software with limited database based on approved story telling document. This delivery consists of representative screens of masters and transactions, queries and reports. It is intended to provide an early preview to the application and the screens at this stage are typically non-functional (mock up). It contains sample complex screens demonstrating unique navigational patterns. It would give an insight into navigational structure, look and feel of module. This stage is once again to be approved by a committee of Engineer in charge, User and contractor. User can give large amount of inputs for improvement of the interfaces at this stage. All such improvements are to be incorporated in Beta stage.

iii) Beta Stage: In this stage, all the screens, processes and reports are developed and delivered. There may be Blocker and/or lower level bugs which may hamper testing in certain areas. Essentially, this stage is intended for testing by Engineer in charge through which contractor would get first round of feedback. Certain areas of application would still be in development stage at this point of time. Such areas would be listed out. There may be some known issues like performance etc., which would also be listed out. All such issues listed out would be covered in Gamma stage.

iv) Gamma Stage: At this stage of delivery, all the development is over and all the issues listed in earlier stages are taken care of. There is no Blocker that can hamper test paths. However, there may be Critical or Lower level bugs which will be tracked to their closure in a structured way.

v) Final Production ready stage: At this stage of delivery, all the bugs of the type BLOCKERS, CRITICAL, MAJOR and MINOR are taken care of. Any mutually agreed upon issues are also rectified. Thus, this delivery is the release for implementation. The trivial bugs will be taken up and corrected during implementation period.

vi) Above stages are meant for customized development of software modules like: MIS reports, Crew management, decision support etc. Standard software modules like train describer, time tabling etc. can directly start from Alpha stage.

12. INTEGRATION WITH GSM(R) BASED MOBILE TRAIN RADIO SYSTEM

i) A Mobile communication is being provided between the Loco Pilot & the Section Controller in OCC as a part of this contract.

ii) TMS system shall be integrated with GSM(R) based Mobile Train Radio Communication system.

Suitable arrangement will be provided for entering of Train ID in Cab radio at the starting station of DFCCIL route and its confirmation from TMS by Radio Server. Details of the same shall require consent of the Engineer at Design stage.

13. SPARES

The Tenderer shall submit a list of recommended spares along with their costs which shall be required to be stocked for proper upkeep of the system. However, following guidelines shall be followed while preparing this list.

i) SPARES FOR Electronic Cards/ Modules: As specified in Chapter 13 of Vol. III Part 1 of Bid Documents.

ii) SPARES FOR TERMINALS: Complete Terminals including VDU shall be supplied as spare. Quantity of the same shall be 10% of total supplied terminals subject to minimum 1 (one) of each type.

14. DOCUMENTATION

The manufacturer shall supply the following sets of documents. Guidelines contained in GS and PS on documentation shall be followed.

14.1 User manual: This Manual is meant for users of TMS explaining basic operation of data entry, data recording, generation of reports etc.

14.2 Operator manual: This manual is meant for System operator, who manages the system, controls individual operators, generates authorization, and supervises the functioning of system.

14.3 Programming manual: This manual is meant for Technical staff and will be used for programming the changes in display, incorporating changes in name of station, yard layout change, adding and deletion of new station, addition and deletion of new controllers etc.

14.4 Service/trouble shooting Manual: This manual is meant for technical staff and will be used to attend the various failures and troubleshoot the fault. The manual shall guide step by step to arrive at the exact fault.

14.5 Maintenance cum Technical manual: This manual is meant for technical staff and guides step by step for carrying out the various periodical & preventive maintenance checks and backups to be taken to prevent loss of data/software.

14.6 Schematic installation drawings: These drawings indicate the various arrangements of TMS like various controller terminals, it's layout, inter connections of the terminals, arrangement of LAN, configuration of equipment, the equipment installed at various locations etc.

14.7 Installation, operation & maintenance manuals: These shall be supplied as per details given in GS/PS.

15. TRAINING & TRAINING DOCUMENTS/GADGETS

Training shall be imparted to DFCCIL officials as per details given in GS/PS.

ANNEXURE – A to Annexure 2

BASIC APPLICATION DATA INPUT TO THE SYSTEM

A **Fixed Data**

i) Working Time Table;
ii) Geographical data (station layouts along with signalling arrangements, crossovers / points, gates, tracks, signals etc.);
iii) Loco Pilot booking schedule (sets);
iv) Any other data prescribed by the Employer.

B **On Line Data Input**

This shall be collected automatically by the TMS system from various interlocking, Porta huts, Level crossing gates etc. on real time basis and shall include but not limited to the following:

- Status of main signals (G/YY, Y, R, Flashing);
- Shunt signals;
- Calling-ON signals;
- Points set in Normal and reverse;
- Points failure indication in both Normal and Reverse;
- Points Health Monitoring output;
- Crank Handle IN/OUT status;
- Route set / release by passage of train;
- Axle Counter clear/occupied/error;
- All relays picked up / dropped status;
- Any mismatch between output of Electronic Interlocking (EI) and corresponding relay e.g. EI keeping the output for relay dropped but Relay picking up;
- Level crossing gate in open / closed position etc.
- PSS
- ELD
- All types of alarms
- Opening / closing of Signal equipment room and Auto Location Hut doors.
- Status of Air Conditioning at Porta Huts.

C **Train Identification Information**

a. Train No.
b. Destination
c. Platform No.
d. Name of Loco Pilot.
e. Type of load e.g. Container, Food grain etc.
f. Any special features.

i) Above information is to be keyed in by the train originating station ASM, manually from his terminal.

ii) Generally complete information shall be required to be keyed in once only when load enters in the system (either from Electric Loco Maintenance ELMD / sidings / or other entry points) for the first time. Thereafter, system will display all the information. ASM will only be required to confirm the same and modify if required.

iii) Train identification information shall be keyed in by the Section Controller in case concerned ASM has not done so.

D **Loco Pilot Booking Details**

i) This shall be manually keyed in by Crew controller at designated Lobby (or at any other crew booking point) on his terminal during night time for next 24 hours.

ii) Deviation for the booking schedules shall be entered by Crew controller on train to train basis.

E **Data to be keyed in by Section Controller**

i) Train identification on getting NDA alarm (if not entered by concerned ASM);

ii) Remark & cause for any unusual incident;

iii) Selection of trains in case of cancellation;

iv) Messages / Information for Panel ASMs for diversion / cancellation of trains;

v) Message / Information will draw attention of ASM by flashing audio-visual indication;

vi) Manipulation in train graphs for decision making;

vii) Location data and value of Temporary Speed Restriction (TSR).

F **Interrogation Input from Wayside Terminals**

The station ASM shall be able to interrogate the Central Server for any train related / siding occupancy queries.

G **Loco Controller**

i) Normally system shall automatically update position of loads in various sidings. However, facility shall be provided to ASM terminals to enter the details / occupancy of sidings in station yards.

ii) Loco controller shall input the details of locos identified for withdrawing and sending to ELMD for maintenance and repair including planned movement. This information shall be normally keyed in twice a day in respect of the locos to be withdrawn.

H **Other Controllers (Signal, Engg. TPC, etc.)**

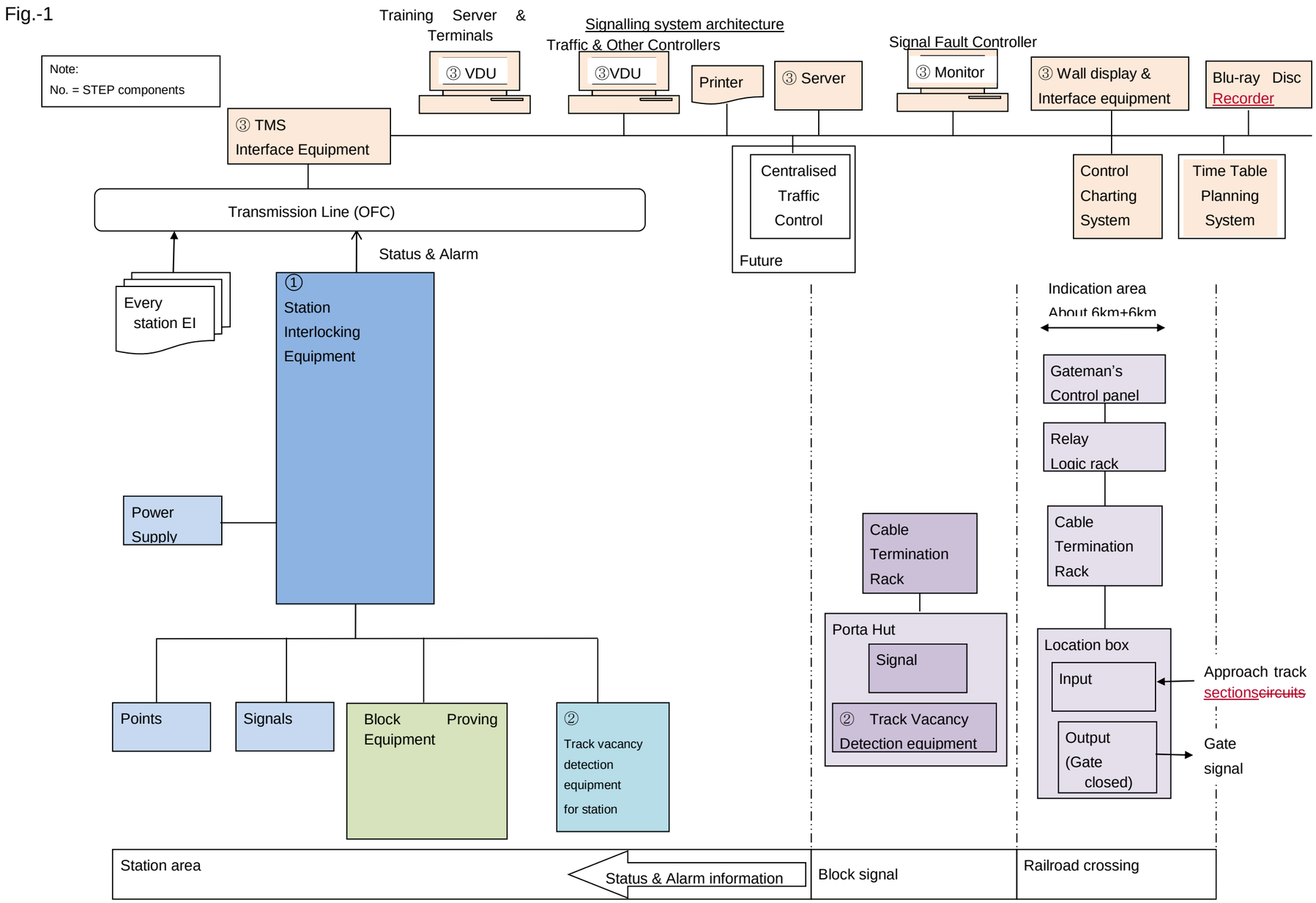
They shall input remarks / information pertaining to various unusual occurrences e.g. failures & delays to operation etc.

NOTE: Application Data input mentioned above is to be finalized in consultation with the Engineer after award of contract.

* * * End of Annexure 2 * * *

(Please see conceptual system sketch on next page)

Fig.-1


Signalling system architecture
Training Server & Terminals
Traffic & Other Controllers
Signal Fault Controller
Note:
No. = STEP components
③ VDU
③VDU
Printer
③ Server
③ Monitor
③ Wall display & Interface equipment
Blu-ray Disc Recorder
③ TMS Interface Equipment
Transmission Line (OFC)
Centralised Traffic Control
Future
Control Charting System
Time Table Planning System
Status & Alarm
Every station EI
①
Station Interlocking Equipment
Indication area
About 6km+6km
Gateman's Control panel
Relay Logic rack
Power Supply
Cable Termination Rack
Cable Termination Rack
Porta Hut
Signal
② Track Vacancy Detection equipment
Location box
Input
Output (Gate closed)
Approach track sectionscircuits
Gate signal
Points
Signals
Block Proving Equipment
②
Track vacancy detection equipment for station
Station area
Status & Alarm information
Block signal
Railroad crossing

Annexure 3: List of Junction and Crossing Stations in DADRI – REWARI section (Phase 2)

P-14 List of Stations (Junction Stations shown in Bold)

	JS - 2, CS - 3		
	Station Name	Inter Station distance (Kms)	
	Rewari (Part of P-5)	0	
CS1	Dharuhera	14	P14 (128 kms)
CS2	Mewat	32	Rewari - Dadri
JS1	**Pirthala**	34	
CS3	Faridabad	33	
JS2	**Dadri**	13	

* * * End of Annexure 3 * * *

Annexure 4: NOT USED.

* * * End of Annexure 4 * * *

ANNEXURE 5: CHAPTER XIV OF IRSEM - SAFETY DEVICES TO BE PROVIDED AT L.C. GATES

Chapter XIV of Indian Railway Signal Engineering Manual (IRSEM) Part-II (Annexure 10-Revised)						
Comprehensive Policy on Provision of Safety Devices at Level Crossings						
	Spl. Class	**A class**	**B1 class**	**B2 class**	**C class (Manned)**	**Other Stipulations**
TVU -->	**>50000**	**>30000 and <50000**	**>25000 and <30000**	**>20000 and <25000**	**>3000 Cat I &>2500 Cat II**	
1. Interlocking of Gates with Signals.						
a) Within Station Limits	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals in Suburban Section, in Automatic Block Signalling. In Non-suburban section, it should be Interlocked with Station Signals, if the LC Gate is operated from the nearest Cabin or if it has to be interlocked for any other reason irrespective of the place of operation.	To minimize the Mean Waiting Time for road users, the arrangement of Interlocking should be such that the last operation before taking 'OFF' of Signal should be the closing of the Gate and the first operation after the train has cleared the Level Crossing and the Signal is put back to 'ON' position, should be opening of the Gate by the Gateman.
(b) Outside Station Limits	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals in Automatic Block Signalling Sections.	i) In case of level crossing protected by signal, where the sighting of the signal by an engine driver is inadequate and the Gate signal is not pre-warned through other means (Distant Signal / Independent Warner Signal / Repeater Signal etc.), a Warning Board should be placed at not less

Chapter XIV of Indian Railway Signal Engineering Manual (IRSEM) Part-II (Annexure 10-Revised)						
Comprehensive Policy on Provision of Safety Devices at Level Crossings						
	Spl. Class	**A class**	**B1 class**	**B2 class**	**C class (Manned)**	**Other Stipulations**
TVU -->	**>50000**	**>30000 and <50000**	**>25000 and <30000**	**>20000 and <25000**	**>3000 Cat I &>2500 Cat II**	
						than the emergency braking distance in the rear of the Gate Stop Signal. The board should be vertical 2000 mm by 450 mm with alternate black and yellow strips 125 mm width painted on it at an angle of 45 degree. The top of the board should be 4 M above rail level. The board need not be lit at night but should as far as possible be provided with scotchlite or other effective light reflectors or retro-reflective tape.
						ii) Where level crossing is situated outside station limits but in close proximity thereof, the clear distance between the level crossing and an outer signal should not be less than the full train length.
Note: All manned level crossing gates both within and outside station limits falling on suburban sections and Automatic Block Signalling section shall be interlocked irrespective of the classification / TVUs of the gates.						
c) Normal Position of Gate	Shall be normally kept open to Road Traffic				If Interlocked, shall be normally kept open to Road Traffic.	

Chapter XIV of Indian Railway Signal Engineering Manual (IRSEM) Part-II (Annexure 10-Revised)						
Comprehensive Policy on Provision of Safety Devices at Level Crossings						
	Spl. Class	**A class**	**B1 class**	**B2 class**	**C class (Manned)**	**Other Stipulations**
TVU -->	**>50000**	**>30000 and <50000**	**>25000 and <30000**	**>20000 and <25000**	**>3000 Cat I &>2500 Cat II**	
Chapter XIV of Indian Railway Signal Engineering Manual (IRSEM) Part-II (Annexure 10-Revised)						
Comprehensive Policy on Provision of Safety Devices at Level Crossings **Year 2010**						
	Spl. Class	**A class**	**B1 class**	**B2 class**	**C class (Manned)**	**Other Stipulations**
TVU -->	**>50000**	**>30000 and <50000**	**>25000 and <30000**	**>20000 and <25000**	**>3000 Cat I &>2500 Cat II**	
2. Telephonic Communication from the Gate Lodge.						
Within or Outside Station Limits	Telephone be provided with ASM's office with **all Manned** Level Crossing Gates.					In Block Sections having large number of Level Crossing Gates, the connections should be uniformly distributed between the Block Stations.
3. Warning Bells or Hooters Operated by Approaching Train.						
Within or Outside Station Limits	Should be provided.	Should be provided.	Should be provided.	Should be provided.	Should be provided, where Level Crossing is Outside the Station limits in all Suburban Sections and Non-suburban Sections provided with Automatic Block Signalling Territories.	Provision of warning bells operated by Approaching Trains should be confined to Interlocked Level Crossing Gates only. Hooters shall be provided, where ever power supply is available.

Chapter XIV of Indian Railway Signal Engineering Manual (IRSEM) Part-II (Annexure 10-Revised)						
Comprehensive Policy on Provision of Safety Devices at Level Crossings						
	Spl. Class	**A class**	**B1 class**	**B2 class**	**C class (Manned)**	**Other Stipulations**
TVU -->	**>50000**	**>30000 and <50000**	**>25000 and <30000**	**>20000 and <25000**	**>3000 Cat I &>2500 Cat II**	
4. Type of Lifting barrier						
a) Within or Outside Station Limits	Electrically Operated Lifting barrier.	Electrically Operated Lifting barrier.	Electrically Operated Lifting barrier.	Electrically Operated Lifting barrier.	Electrically Operated Lifting Barrier in Sub-urban Section.	In Non -suburban Section, Electrically Operated Lifting Barrier be provided, where Power Supply is Reliable.
5. Approach Locking						
	(i) To be provided in Sub-urban Section. (ii) Dead Approach Locking with Timing of **30**secs in other sections.				(i) To be provided in Sub-urban Section. (ii) Dead Approach Locking with Timing of **30**secs in other sections, where Electrically Operated Lifting Barriers are provided.	

* * * End of Annexure 5 * * *

ANNEXURE 6: POLICY OF TRAIN OPERATION PLANNING ON WDFC

1. PURPOSE

1.1 The train operation plan is a base of DFC system including station layout & railway systems.

2. INTRODUCTION

2.1 Network of the Western Corridor includes DFC line and feeder lines operated by IR. It is most important to clarify the policy of train operation planning for trains on DFC only and trains interoperated on DFC and IR lines.

3. DISCUSSION

3.1 Traffic

(1) Block Working between IR station to DFC station at junctions.

(2) There should not be any surface crossing for train between IR & DFC excepting Banas, Keshavganj and Bangurgram for cement plant sidings and at Marwar.

(3) Freight trains on IR, for which DFC would provide the most logical (shortest and/or fastest) route to be assigned to DFC, provided they cross 2 or more consecutive junction stations over the DFC.

(4) Time table running of goods trains on DFC – normally trains to run on charted paths only including premier path.

(5) Number and location of crew changing stations - should be **at an interval of 500kms**. The interval is calculated for less than 8 hour running time assuming average speed 65kmph. The booked speed of trains will be 80 kmph and maximum permissible speed is 100 kmph. The target time of crew change is assumed as 10 minutes at the station.

(6) Issue of crew owned by DFCCIL will be examined further.

(7) Double Stack Container (DSC) train with well type wagons and Single Stack Container train will run from the beginning.

(8) The projected level of traffic on Western Corridor is over 130 trains for 2021-2022 onwards **which calls for long haul operations**. Long haul trains will be required to be run from the very beginning for minimising adverse effects of signal/rolling stock failures, rail fractures, breakdowns, accidents, etc. Intermediate Starter signals should be provided on long loops (1500m CSRs) to start with at Junction stations and subsequently at Crossing (roadside) stations. Distributed power system (Locotrol) should be introduced for long haul operation from the beginning.

(9) Trains will run with End of Train Telemetry (EOTT) or Last Vehicle Detection (LVD) without Brake Vans (BVs).

Trains should run with EOTT/LVD, from the very beginning, at least on selected feeder routes of Phulera, Palanpur, Marwar Jn., Mehsana, Sabarmati, Dahej/Hazira ports, Mumbai area and JNPT.

(10) Diesel Locos should be changed at junction stations of DFC. No diesel fuelling station is required. However, electric locos of IR with high rise panto having adequate power and having its destination within 150-200km, entering WDFC may not be changed. Otherwise locomotive will be changed at Junction station. Feeder routes in western coast should be progressively electrified.

(11) Last loop at junction stations need not have facilities for handling Container trains/Rail Runners in the beginning. The same will be developed as and when required.

(12) Movement chart will be prepared by the computers. Therefore, daily moving charts may be prepared incorporating temporary speed restrictions imposed by P/W

engineers. Copies should be made available at originating stations of feeder routes and junction stations on DFC.

(13) If Phase II does not come simultaneously with Phase I, phase working at Makarpura Jn. station should enable dispatching to and receiving trains from IR. Similarly, if the Eastern and Western Corridors of DFC do not come simultaneously, phase working plan should be prepared for transfer of trains between Eastern and Western Corridor via IR route and Eastern/ Western Corridor and IR.

3.2 Civil Engineering

(1) CSRs of the loops should be 1500m. All junction stations on DFC to be provided with 1500m (CSR) loops from the beginning. Loops at crossing (roadside) stations will initially be 750m (CSR) long which will be extended to 1500m (CSR) at a later date.

(2) The decision was made to adopt 1 in 12 turnouts to save space. There is need to take maximum speed potential of 50kmph on these turnouts.

(3) It was decided to provide 4 hours Corridor Maintenance Block (CMB) for 6 days in a week normally, 3 days in the UP direction and 3 days in the DN direction.

(4) All scheduled/preventive etc. maintenance including ballast trailing/unloading to be undertaken during CMB.

(5) Number and location of Integrated Maintenance Depots (IMDs):

(a) IMDs cover approximately 160kms. Sub-depots are proposed at stations approximately at 80 kms. interval.

(b) OHE and S&T depots should be located at IMDs.

Refer Vol. V for final Location of Depots & Sub-depots.

(6) Ballast depots should work round the clock. The ballast train should run preferably at maximum permissible speed of 100kmph. If it is less than 100kmph, it will run and work only during Corridor Maintenance Block.

(7) Maximum running speed of Ultrasound Testing Vehicle, Track Recording Car should be 100kmph. Working speeds of Ultrasound Testing Vehicle, Rail Grinding train, Ballast Cleaning machine, Track Machines etc. being less than 100kmph should work during CMB.

(8) C&W maintenance will be entirely IR's responsibility.

(9) Substructure, formation including embankment and cut, and bridges to be planned for 32.5t axle load. However, initially track will be planned for 25t axle load.

3.3 Safety

(1) Level Crossing (LX) Gates with more than 25,000 TVU will have either ROBs or RUBs. LXs with less than 25,000 TVUs will be interlocked in such a way that normally these will be closed to road traffic. Only a single set of road barriers to be provided covering both IR and DFC tracks and the same would be operated by gateman of IR. To facilitate opening of gates, occupancy of Axle Counter Track sections on either side of the Level crossing should be displayed in the goomty of IR's gateman.

(2) DFCCIL will also have separate General Rule (GR) & Special Rule (SR) and since only goods trains will run on DFC, MD/Director Project/Director Infrastructure, DFCCIL will be empowered to open new lines/sections

(3) DFCCIL will be authorised to issue SR, Operations Manual, Working Time Table, Rules for Abnormal Working etc.

3.4 Mechanical Engineering

(1) At present Accident Relief Trains (ARTs)/Breakdown Cranes will be provided at

Sabarmati (South) and Sardana. IR's breakdown cranes and ARTs should be used wherever possible.

(2) DFCCIL's ARTs are planned as under:

(i)	140t breakdown crane and ART	Sabarmati (South) and Sardana
(ii)	Road-cum-Rail ART with hydraulic jacking system	Rewari, JNPT

The help from adjacent IR network will be available for attending emergency.

(3) Number and location of rolling stock monitoring facilities:

Hot box detector & wheel impact detector should be at the entrance of every important junction station. The final decision has not yet been taken. The decision will be made after discussions with MOR and after cost details are studied. Consultants strongly advise that the hot box detectors should be spaced every 30 to 50km, or not used at all, as greater spacing will not be effective in detection of hot bearings and derailment prevention.

(4) Hot axle sidings may be provided at the alternate stations.

3.5 Traffic and S&T

(1) TPWS should be provided from the beginning.

(2) OCC Building is planned in or around Ahmedabad city.

(3) Points and signals will be operated by station masters locally. (Route control will be done at every station.) However, provisions for centralised traffic control in future should be made.

(4) Multi Modal Logistic Parks (MMLPs) are proposed to be located at New Mumbai, Ahmedabad area and Rewari on Western Corridor.

(5) For working/ running track machines, cranes/ART during accidents etc., shunt signals provided should be used for wrong line movement through emergency crossovers.

(6) For combining two trains into "Long Haul" and breaking a Long Haul train into two single trains, "Intermediate starter signal" should be provided on 1500m (CSR) long loops having intermediate crossovers.

(7) Crew headquartered at Makarpura will work trains between Makarpura and JNPT/ Kharbao and Hazira (or Gottangaon). The same crew and Loco may ideally work trains right upto Hazira and Dahej ports. Similarly Makarpura and Marwar based crews will work trains between Makarpura and Marwar. Therefore, both Makarpura and Marwar will have quarters as well as running rooms for crew. Crews based at Marwar and Rewari will work trains between Marwar and Rewari.

(8) It may be decided whether IR or DFC crew should work trains from Rewari to ICDs in NCR and back. Trains coming from or going to Mundra and Kandla ports should be run by Palanpur and Phulera based crews. These trains between Phulera and up to the ICDs in NCR and back may be worked by Phulera based crews.

3.6 Electrical Engineering

(1) The high rise pantographs will be fitted with locos running on feeder routes. They are already procured and being installed by IR.

(2) Transition section of OHE height 5.5m/7.45m will be installed at entrance of the junction stations.

3.8 Electric locomotive shed is planned at Rewari.

* * * End of Annexure 6 * * *

ANNEXURE 7-1: PHYSICAL INTERFACE BETWEEN RS P-7 & CT P-14: SPECIFIC ISSUES

1. INTERFACES

Interfaces between RS P-7 and CT P-14 Contracts shall include but shall not be limited to the items included in interface matrix below:

S.No.	ITEM OF WORK	CT P-14	RS P-7
1.	Track side Signalling and interlocking system	(i) Shall install Signalling and interlocking system on Dadri – Rewari section). (ii) Provide interference current limits to RS P-7 and test the same.	Ensure that interference currents are within limits. Associate in its measurement by CT P-14.

* * * End of Appendix 7-1 * * *

Annexure 7-2 (Revised): INTERFACE ISSUES BETWEEN IR, EDFC & CT P-14 PERTAINING TO SIGNALLING

1. Definition and Scope

1.1 This Appendix describes the interface requirements between CT P-14 Contractor and IR/ EDFC.

1.2 All interface shall be through the Employer. Interface circuits from/to IR/ EDFC Junction stations shall be extended by the CT P-14 Contractor. Signalling arrangement between IR/ EDFC Junction stations and WDFC stations shall be provided by the CT P-14 Contractor. However, all signalling work at IR/ EDFC Junction stations including incorporation of interface circuits/ Block circuits into local circuits shall be carried out by IR/ EDFC respectively. CT P-14 Contractor shall coordinate with designated agency of IR/ EDFC for this purpose.

1.3 Throughout this Appendix, 'the Contractor' shall mean the CT P-14 Contractor, whereas 'the Contract' shall mean Contract CT P-14.

1.4 The interface issues between the Contractor and IR/ EDFC shall have to be identified. Such issues arise primarily at the following interfaces: -

- The Signalling arrangement on interconnection line at junction stations and existing sidings;
- Level crossing working where it serves both IR/ EDFC and WDFC lines running side by side;

1.5 The scope shall comprise of but not limited to the following:

- Control and indications for signalling between WDFC and IR/ EDFC junction stations and existing sidings;
- Protection of existing cables and other gears of IR/ EDFC while carrying out works on WDFC;
- Control and indications for Level Crossing working where it serves both IR/ EDFC and WDFC lines running side by side;
- Earthing & Bonding;
- Signage;
- EMC/EMI;
- Integration testing;

- Exchange of data of train runs between WDFC and IR/ EDFC for Freight Operations Information System (FOIS);
- Provision of TMS terminals at required locations of IR/ EDFC to enable crew management at Junction stations.

1.6 Following guidelines shall be followed while providing signalling arrangement with IR/ EDFC's Junction stations:

(a) Wherever BPAC is provided, half set of BPAC equipment to be provided at IR/ EDFC's station shall be handed over by the Contractor to IR/ EDFC's designated representative for installation by IR/ EDFC.

(b) The signalling cables required for working the signalling arrangement including Block/ Slot working shall be laid by the Contractor to cover at least the length of connecting line constructed by WDFC. Details of the same shall be decided by the Contractor with IR's representative during interface at design stage.

1.7 Wherever connection to existing sidings is getting shifted from IR to WDFC, set of equipment for Block working of siding presently working at IR station shall be collected by the Contractor from IR's designated representative and provided at WDFC station.

1.8 Gate signals for trains on IR/ EDFC tracks shall be provided and operated by IR/ EDFC respectively.

1.9 Where separate set of barriers have to be provided for IR/ EDFC and WDFC tracks due to site requirements, supply and installation of Electric lifting Barrier for IR/ EDFC track shall be done by IR/ EDFC.

2. Communications

2.1 All communication between the Contractor and IR/ EDFC shall be via the Employer as per 1.2 above.

* * * End of Appendix 7-2 *** * ***

ANNEXURE 7-3: INTERFACE ISSUES BETWEEN ST P-5, CT P-14 and To Be Decided (TBD) Contractor

1. Definition and Scope

1.1 This Appendix describes the interface requirements between ST P-5 Contractor and Phase 2 (Dadri – Rewari section) Contractor CT P-14 and also TBD Contractor. TBD Contractor shall be responsible for Signalling works in Backup Control Centre (BCC).

1.2 All interface shall be through the Employer.

1.3 Throughout this Appendix, 'the Contractor' shall mean the CT P-14 Contractor, whereas 'the Contract' shall mean Contract CT P-14.

1.4 The interface issues between the Contractor and ST P-5 and TBD Contractors shall have to be identified. Such issues arise primarily at the following interfaces: -

(i) The Signalling arrangement on interconnection at stations where boundaries of Phase 1 and Phase 2 (Dadri – Rewari section) meet;

(ii) TMS provision for Phase 2 (Dadri – Rewari section);

(iii) Working between Main and Backup Control Centre (BCC).

1.5 The scope shall comprise of, but not limited to, the following:

(i) Control and indications for signalling at stations where boundaries of Phase 1 and Phase 2 (Dadri – Rewari section) meet;

(ii) Control and indications for signalling in Block sections next to stations where boundaries of Phase 1 and Phase 2 (Dadri – Rewari section) meet;

(iii) Incorporation of Phase 2 (Dadri – Rewari section) power supply requirement in PSS of OCC;

(iv) BCC:

a) Real time updating of data/ status;

b) Automatic changeover offer to BCC when both main and standby servers in main OCC fail or shut down;

c) Facility of forced takeover by authorised personnel in BCC and vice versa in main OCC.

(v) Detailed methodology of providing integrated TMS for the whole line shall be jointly worked out by all interfacing Contractors and got agreed by the Engineer. Methodology in which this is achieved by having single set of Main/ Standby servers provided by ST P-5 Contractor in OCC and CT P-14 Contractor providing required data for his section in the agreed format for uploading shall be preferable.

(vi) Updating of software in TMS servers in OCC so as to cover Phase 2 (Dadri – Rewari section) works for all prescribed functionalities;

(vii) Earthing & Bonding;

(viii) Signage;

(ix) EMC/EMI;

(x) Integration testing;

1.6 ST P-5 shall be the lead Contractor.

* * * End of Appendix 7-3 *** * ***

ANNEXURE 8: SPECIFICATIONS OF PRE-FABRICATED PORTA HUTS

1 **General**

1.1 Pre-fabricated structures shall be of steel construction.

1.2 All pre-fabricated structures shall be resistant against shock and vibration from passing trains.

1.3 The construction must be water proof against rainfall.

1.4 Air-conditioning and ventilation equipment shall be provided with suitable antitheft arrangements.

2 **Wall Construction**

2.1 External facing shall be of galvanized sectional sheet-metal.

2.2 Adequate thermal insulation shall be provided by using Polyurethane Foam (PUF) of adequate thickness.

2.3 Doors of adequate size to permit entry of largest equipment cabinet. Door locks to be provided. Opening and closing of doors shall be monitored through TMS.

3 **Roof Construction**

3.1 The roof shall be protected from sun heat with adequate thermal insulation.

3.2 Height shall be sufficient for installation of equipment to ensure running of cable/wiring trays and provision of tube lights.

3.3 NOT USED.

3.4 Adequate and suitable drainage system for roof and the whole area outside shall be provided.

3.5 Roof structure may be formed by pitch roof panels and trusses covered with OSB radiant barrier roof panels/sandwich panels of adequate size or any other equivalent.

3.6 The surface obtained after the implementation/application of OSB covering shall then be applied with requisite number of layer waterproofing membrane.

3.7 Subsequent process shall be application of shingle waterproofing membrane of suitable colour and texture as roof covering material to make it waterproof for climate conditions in the project section.

4 **Floor Construction**

4.1 Sub-floor shall be of galvanized sheet metal.

4.2 It shall be made waterproof with bonded hardboard plates.

4.3 Good thermal insulation shall be achieved using Polyurethane Foam (PUF) or any other equivalent suitable material of adequate thickness.

4.4 Floor openings for cables as needed shall be provided.

5 **Floor Covering**

5.1 Elevated double floor may be provided only if rack to rack/rack to equipment cabinets overhead cabling/wiring is seen to be problematic.

5.2 Carrying capacity 20 kN/m^2, at a point load capacity of 3,000 N or adequate to cater for maximum load requirement.

5.3 Surface shall consist of PVC covering/tiles.

6 **Corrosion protection**

This shall be achieved using following measures:

6.1 Frame construction: Shot-blasted with steel and primed.

6.2 Facing of sectional sheet-metal, galvanized.

6.3 Sectional sheet-metal for roof, galvanized and preferably plastic-laminated or any other equivalent.

6.4 Flat-type sheet-metal for dead floor, galvanized.

7.0 **Electrical Installation**

7.1 Space for Auto change over switch and termination of AT supply from UP & DN Catenary to be provided.

7.2 Internal electrical wiring & fixtures for light, power socket etc. shall be provided.

8 **Foundation**

8.1 Provision of concrete foundations including earth work, if necessary, to be done.

8.3 Channels and openings required for cables leading to the individual structures shall be designed in a way that replacement of cables is possible. Cable entry shall be Rodent & pilferage proof.

9 **Lightning Protection**

9.1 The outdoor lightning protection shall cover persons as well as all equipment and facilities to be protected.

9.2 The lightning current shall be captured and discharged to the earthing system.

9.3 Air termination network consisting of lightning conductors and lightning rods shall be installed. Traction earth may be used if available nearby. Otherwise, a ring-shaped earth shall be used for discharging the lightning current. The tracks must not be used as part of the lightning protection system.

10 Air Conditioning

10.1 Each Porta Hut shall have two rooms, one for Electronic Equipment and the other for Power Supply/Battery System. Electronic Equipment room (including for electronic equipment provided by ST P5-A Contractor) shall be provided with suitable Air-conditioning system (if required) in (1+1) hot standby configuration. Air Conditioning units shall be provided with programmable automatic changeover arrangement with nominal setting at 12 Hrs. In case standby unit is defective, this automatic changeover shall not take place.

10.2 The Power Supply/Battery Room of the Porta Hut shall be provided with ventilation and suitable means to regulate temperature and maintain air-circulation with (1+1) standby air-circulation system.

10.3 A suitable plan of the Porta Hut shall be submitted to the Engineer for his consent as part of the Preliminary Design.

11 The entire design shall be pilferage proof.

* * * End of Annexure 8 * * *

ANNEXURE 9: GUIDELINES ON SIGNALLING CABLE LAYING

Government of India - Ministry of Railways
Research Designs & Standards Organisation
LUCKNOW – 226011

GUIDELINES
ON
SIGNALLING CABLE LAYING

Number of Pages - 44

Issued by

SIGNAL DIRECTORATE

RESEARCH, DESIGNS & STANDARDS ORGANISATION
MINISTRY OF RAILWAYS
MANAK NAGAR
LUCKNOW – 226 011

October 2011

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1. Background

1.1 The Signal Engineering Manual (SEM) covers broadly various instructions on laying of signalling cables. Railway Board have also issued guidelines on the subject from time to time. This issue of cable laying practices has also been discussed in many forums like CSTE's Conference, MSG's etc.

1.2 On account of multiple faults in the cable and inadequate protection arrangement against short/open circuit faults, failures of point and other signalling gears have taken place on various Zonal Railways. In some of the cases, Railways signalling cables are invariably damaged by JCB & other track machine operated by Engineering Department, which resulted in serious dislocation to train services inviting criticism from different quarters. In view of this, board has asked RDSO to prepare detailed instruction for laying of signaling cable.

1.3 Following documents are also considered while preparing this document:-

1.3.1 Railway Board's Joint Procedure Order No. 1/SG/2004 issued under D.O. letter No. 2004/Sig/G/7 dated 17.12.2004.

1.3.2 Railway Board's letter No. 2004/Sig/A/WR/1 dt. 20.07.2007 enclosing Joint Committee Report No. SS-117/2007 and RDSO's comments on the report.

1.3.3 Cable Laying Practices followed by various Zonal Railways i.e. CR, WR, SR & RE etc.

1.3.4 Railway Signalling Installation and Quality Handbook.

1.4 These guidelines on signalling cable laying containing consolidated instructions on the subject are being issued for uniform adoption by Railways.

2. General

2.1 Railway signalling circuits shall normally be carried on cables. For new works, signalling circuits shall only be carried on cables. In 25 KV AC electrified areas overhead lines shall not be used.

3. Planning for cables

3.1 Cables used for carrying signalling, circuits shall conform to relevant approved specification. The conductors used shall be of annealed copper and of approved size. For this purpose, specification No. IRS:S 63 may be referred.

3.2 Power cable used for carrying power supply for signalling circuits shall conform to relevant approved specification. The size of conductor shall be so selected as to suit the electrical load. For this purpose, specification No. IRS:S 63 may be referred.

3.3 The Core-wise usage of signalling cable is as given below:-

Core & Cross section	RDSO Specification	Usage
6 Core × 1.5 mm^2	IRS S 63	Tail Cable
12 Core × 1.5 Sq. mm^2	IRS S 63	Tail Cable/LC Gate/ Main Cable
19 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
24 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
30 Core × 1.5 Sq. mm^2	IRS S 63	Main Cable
2 Core × 2.5 Sq. mm^2	IRS S 63	Track circuit lead connections
12 Core × 2.5 Sq. mm^2	IRS S 63	Main/Tail Cable
2 Core × 16 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 25 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 35 Sq. mm^2	IRS S 63 & IS 1554	Power cable
2 Core × 50 Sq. mm^2	IRS S 63 & IS 1554	Power cable
4/6 Quad Cable (0.9 mm)	IRS TC:30	Axle Counter

3.4 A cable core distribution plan is required to be prepared for each installation. Cables for power distribution shall be indicated for each signaling gear. A sketch No. SDO/CABLE LAYING/001 showing typical main cable distribution plan including power cable for field gears for a typical double line (4 lines) PI station is enclosed (**Annexure-4**).

3.5 The distribution of various power supplies for operating signalling gear in yard shall be covered in cable distribution plan issued by CSTE of Zonal Railways. However, following guidelines may be followed:-

3.5.1 In general following power supplies and required to distribute on each side of the station:-

(i) 110V AC for track feed battery charger etc.
(ii) 24/60 DC for external for TPR, point detection etc.
(iii) 24 DC external for electronic equipment like Axle Counter, BPAC etc.

3.5.2 The above power supplies as per the requirement of the station may be extended on each side of station and terminated at all main location boxes/huts.

3.5.3 All the power supplies at wayside stations as well as major yards may be laid with redundancy i.e. 2 power cables for each circuit to avoid major signalling breakdown affecting punctuality of train services during any damage/cable becoming faulty. A changeover switch may be provided at either end of the station for extending the alternate power supply in case of failure.

3.5.4 In RE area, for automatic signalling, IBH, mid-section, level crossing gates and at station where location boxes/huts are more than 2 km power supply may be taken from auxiliary transformer.

3.5.5 In Non-RE area, for automatic signalling, IBH and mid-section level crossing gates, power supply may be extended from stations on either side. The arrangement shall be such that the power supply from one of station can be extended while at same time power supply from other station shall remain isolated.

3.6 While planning for cabling on a route, the number of conductors required, for the circuits shall be first determined. Recommended core sizes shall be used.

3.7 Adequate spare conductors to a minimum of 20% of the total conductors used shall be provided for in each main cable up to the farthest point zone, beyond this there shall be a minimum of 10% spare conductors of the total conductors used. The spare conductors shall be provided on the outermost layer. 2 numbers of 12 Core dedicated spare cable from home signal to home signal may be laid and terminated in all locations for instant transfer of these dedicated conductors in case of cable failure and cable testing.

3.8 Where a number of cables have been laid along a route, the circuits shall be so distributed that cables can be disconnected for maintenance purpose with the least possible dislocation to traffic. Line wise and, if necessary; function wise cable shall be provided. Auxiliary signals shall be taken in different cables.

3.9 Separate cables of suitable size shall be laid for point operation.

3.10 Numbering of cable to be done in ascending order from right hand side of the cable core distribution plan.

3.11 Number of location boxes shall be kept at minimum. Where too many locations boxes (say more than 10) are coming in a close proximity generally between starter & home signal, it is proposed to use location huts instead of location boxes for security, proper protection and ease of maintenance. Prefabricated huts (approximate size 10 feet x 10 feet) may be used, the drawing/design of which shall be issued by RDSO separately.

4. Planning for cable route

4.1 After deciding the size and the number of conductors in the different types of cables to be used on a route, a foot survey along the track shall be done to determine the best route for the cable.

4.2 The route shall be shown clearly on a cable route plan showing the actual alignment of track, giving offsets from permanent way or permanent structures. The diagram shall indicate the various road and track crossings, crossing with power cables, water and sewage mains and other points of importance. It is preferable to chart the route on a route plan on which the existing routes of power cables, etc. are shown. Changes, if any, shall be incorporated in the chart/plan.

4.3 While planning cable route plan, any future yard modification/doubling etc. shall also be kept in view.

4.4 Cable route plan shall also be approved by Engineering and Electrical Department. Cable route plan shall also be approved by Branch Officer of Signal & Telecom (Open Line) wherever it is prepared by organization other than open line.

4.5 As far as possible low lying areas, platform copings, drainages, hutments, rocky terrains, points and crossings, shall be avoided.

4.6 Wherever JCB/Mechanized trenching or any kind of digging cases near existing cables is resorted, instructions contained in Railway Board's JPO No. 1/SG/2004 issued under D.O. letter No. 2004/Sig/G/7 dated 17.12.2004 (**Annexure-1**) shall be followed.

5. Laying of cable above ground

5.1 Signalling cables for outdoor circuits shall not normally be laid above ground. In exceptional cases where it becomes unavoidable, the following precautions shall be taken:-

i) The cable shall be suspended in wooden cleats, from cable hangers or in any other approved manner so that no mechanical damage occurs to the cable even under exposed condition.

ii) The cable supports shall be so spaced as to avoid sag.

iii) In station yards, cable shall be laid in ducts suitably protected.

5.2 Indoor signalling cable shall normally be laid on ladders, channels or in any other approved manner. The cables shall be neatly tied/laced.

5.3 In AC electrified areas cables shall be laid underground only. For laying cables in RE area instructions laid down in Chapter XXII of SEM shall also be followed. Extract of this chapter are available in para 22 of these guidelines.

6. Excavation and backfilling of the trenches

6.1 Manual trenching is recommended for laying of signalling cables in the station yards from Home to Home signal and mechanized trenching is recommended from Home to distant signal and beyond into block/automatic section.

6.2 Under road/platforms/railway tracks/difficult terrain etc., trench less horizontal directional drilling (HDD) method may be adopted under the supervision of competent staff for laying of GI/DWC-HDPE pipe. Both ends of GI/DWC-HDPE pipes shall be closed properly using accessories and the pits shall be properly backfilled. There shall be no damage to the road/platform/tracks or any such structures etc. enrooted during or after the HDD operations.

6.3 Excavation of cable trench shall be made in all kinds of soils including clearing roots of trees, rocks etc. Trenches shall be straight as far as possible and steep angles shall be avoided.

6.4 The bottom of the trench shall be levelled and got rid of any sharp materials. No sharp object like stone chips, iron pieces etc. shall ever come in contact with laid cables irrespective of the method of laying the same.

6.5 After cable has been laid and until the whole of the cables to be laid in the trench have been covered with their protective covers, no sharp metal tool such as spades, crowbar or fencing pins shall be used in the trench or placed in such a position that they may fall into the trench.

6.6 When cables are laid in trunking, care shall be taken to see that no ballast or stones have been dropped inside the trunking. The trunking shall be cleared of all ballast and stones before the cover is secured. When the ends of covers are joined together with cement plaster, a piece of paper or wood shall be placed under the joint to prevent the cement plaster from falling on the cable.

6.7 It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.

6.8 Before commencement of the laying, inspection of the trench and inspection of protection works shall be carried out so as to ensure their conformity with the specification. A sketch No. SDO/CABLE LAYING/022 rule made of pipe for measuring depth is enclosed (**Annexure-25**).

6.9 Backfilling of the trenches shall be done properly. The earth excavated shall be put back on the trench, rammed and consolidated.

6.10 During excavation, the earth of the trenches shall not be thrown on the ballast. The earth shall be thrown by the side of the trenches away from the track.

7. Cable laying in underground

7.1 General

7.1.1 Cables may be laid underground, either in the trench, in ducts, in cement troughs, in pipes or in any other approved manner.

7.1.2 Cables shall be laid generally as per instructions given in these guidelines. However, special precautions to be taken in the station yards etc. where a number of other utilities may be existing, may be detailed in a joint circular issued by the Civil Engineering, Signalling and Electrical Department (where applicable) of the Railway. Railways may provide any additional protection as necessary at a particular location due to prevailing law and order problem.

7.1.3 Cable is generally laid parallel to the track beyond Home signal with minimum deviations and on one side of the yard.

7.1.4 As far as possible, cable shall be crossed only at two locations, i.e. one crossing on each side of the yard.

7.1.5 The cable laid parallel to the track shall be buried at a depth of minimum 1.0 metre (top most cable) from ground level. A sketch No. SDO/CABLE LAYING/003 showing cable trench is enclosed (**Annexure-6**). While those laid across the track must be minimum 1.0 metre below the rail flanges. However, in case of rocky soil, the depth may be reduced suitably. When it concerns the laying of tail cables which serve the track apparatus etc. the depth shall not be less than 0.50 metres. In theft prone areas the cables may be laid at a depth of 1.2 metres with anchoring at every 10 metres.

7.1.6 The width of manually made cable trenches shall commensurate with number of cables. The minimum width shall be kept as 0.3 meters. The bottom of the cable trench shall be levelled and got rid of any sharp materials. In the soft ground, the cable shall be laid at the bottom of the trench previously levelled. In the rocky ground, the cable shall be laid on a layer of sand or sifted earth of 0.05 metre thickness previously deposited at the bottom of the trench. In both the above cases, the cable shall be covered with a layer of sand or sifted earth of 0.10 metre thickness and thereafter a protective cover of trough or a layer of bricks shall be placed.

7.1.7 Normally, not more than 12 cable are to be laid in one trench as it shall be difficult to attend failure at a later date. At a moderate size station with electrical signaling installation, generally the numbers of cable are more up to home, it is recommended that cables are laid in RCC duct up to home signal on both side of the station and may be extended up to distant, if required. This will also help later for laying of additional cable later without carrying out trenching.

7.1.8 While laying the cables in accordance with the above instructions, the following instructions shall be adhered to for the safety of the track:-

i) Outside the station limits, the cables shall generally be laid at not less than 5.5 metre from the centre of the nearest track.

ii) Within the station limits, the trenches shall preferably be dug at a distance of not less than 3 metre from the centre of the track, width of the trench being outside the 3 metre distance.

iii) At each end of the main cable an extra loop length of 6 to 8 metre shall be kept.

7.1.9 Before starting cabling work location boxes shall first be erected so that cable after laying is directly taken inside location box and its multiple handling/damage by re-digging and taking inside location box/Relay Room is eliminated.

7.1.10 A sketch No. SDO/CABLE LAYING/002 showing position of trenches for cable laying is enclosed (**Annexure-5**).

7.2 Laying of different type of cable in same trench

7.2.1 Where several cables of different categories have to be laid in the same trench, they shall be placed as far as possible in the following order starting from the main track side, so that in the event of failures, the maintenance staff may easily recognise the damaged cables:-

i) Telecommunication cable
ii) Signalling cable
iii) Power cable

7.2.2 A distance of approximately 10 cm must be maintained between telecommunication cable and signalling cables. The signalling cables must be separated from power cables by a row of bricks between them.

7.2.3 A sketch No. SDO/CABLE LAYING/004 showing laying of signalling cable & Telecom/Power cable in same trench is enclosed (**Annexure-7**).

7.3 Cable laying in ducts

7.3.1 RCC, masonry or any other approved type of ducts may be used for laying the cable. The ducts shall have suitable covers and shall rest on walls of duct.

7.3.2 The ducts shall be of such design as to prevent water collecting in the duct.

7.3.3 After placing the trunking in the trench the ducts have to be aligned using 8 mm rod. For this purpose, a hole is left in the trunking for insertion of rods. Wherever there is a diversion proper care shall be taken to cover the cables, either by smoothly forming a curve with duct or a masonry structure can be constructed to protect the cables. After laying of cables the ducts shall be covered with RCC slab and shall be continuously plastered at the end with trunking.

7.3.4 When cables are laid in rocky area, it is desirable to protect them with split RCC ducts of suitable design.

7.3.5 Where it is necessary to take the cable between the tracks, it shall be carried in trunking kept sufficiently below the ballast level.

7.3.6 Cables for longer distances shall be laid on bottom layer. Duct shall be filled up with sand after cable is laid to avoid entry of rodents.

7.3.7 From Home to Home Signal, where number of signalling cables required are more, subject to availability of space adjacent to tracks, RCC ducts with removable top cover with larger width up to 500 mm are recommended to be used.

7.3.8 Beyond Home Signal and up to distant signal including block section/ automatic section RCC ducts with a width up to 300 mm are recommended to be used.

7.3.9 Partition of RCC duct for accommodating different types of signalling/telecom cables/ power cables may be provided, wherever required. This can be achieved by earmarking about 80% of inner space for multi core signalling/ telecom cables and the remaining 20% of space for carrying power cable more than 110V in a separate of chamber.

7.3.10 In RCC ducts it is recommended to have height of maximum 300 mm (outside dimension inclusive of removable top cover). Length of the duct shall be between 700 mm to 1000 mm (outside dimension). This is mainly required for easy transport of ducts from factory premises to the work sites.

7.3.11 Depth of 600 mm to 1000 mm is recommended according to requirement of Zonal Railways depending on site condition and Law & Order situation.

7.3.12 A sketch No. SDO/CABLE LAYING/005, 006 & 007 showing RCC duct is enclosed **(Annexure-8, Annexure-9 & Annexure-10).**

7.4 Laying cable in solid & rocky soil

7.4.1 In case of rocky soil the depth may be reduced suitably.

7.4.2 Sharp edges on the sides must be smoothened out and bottom of the chase shall be leveled. In the rocky ground the cable shall be laid normally on layer of sifted earth of 0.05 meter thickness previously deposited at the bottom of the trench. Cable shall be covered with the layer of sand or sifted earth of 0.1 meter thickness.

7.4.3 In case sharp edge of rocky ground cannot be protected with sifted earth, concrete/GI/CI/PVC/DWC-HDPE pipe shall be used if number of cables are small. If number of cables are large, RCC duct shall be used. In isolated cases, it can be given smooth surface by using either masonry bricks or cement concrete.

7.4.4 A row of bricks shall then be placed lengthwise on the top and jointed with cement mortar and a layer of concrete with cement plaster shall be provided on the top of the same.

7.4.5 A sketch No. SDO/CABLE LAYING/008 showing laying of cables in rocky area is enclosed (**Annexure-11**).

7.5 Laying in special soil condition

7.5.1 Cable shall not be run through abnormally high acidic or alkaline soil or through sewages. If this is unavoidable special measures shall be taken against corrosion. Cable may be laid in the concrete/GI/CI/PVC/DWC-HDPE pipes properly jointed to prevent ingress of moisture.

7.6 Cable laying in residential area

7.6.1 When laying the cable in residential area, the cable shall be specially protected on both sides up to a distance of about 300 metres beyond the building line. In such cases, the cable shall be protected by means of concreting of 50 mm as proposed for rocky soil. This is better than using bricks as in a residential area bricks are usually found while digging and its special significance of cable protection may be overlooked.

7.7 Cable laying in large yard and suburban area

7.7.1 Main signalling cable in large yards including suburban section shall be laid in RCC ducts/DWC-HDPE pipes.

7.7.2 Tail cables shall be laid through DWC-HDPE pipes of suitable sizes and buried in trenches at a depth of not less than 1000 mm from ground level.

8. Track crossing

8.1 As far as possible, cable shall be crossed only at two locations, i.e. one crossing on each side of the yard.

8.2 When a cable has to cross the track, is shall be ensured that-

i) The cable crosses the track at right angles;

ii) The cable does not cross the track under points and crossings and

iii) The cable is laid in concrete/GI/CI/PVC/DWC-HDPE pipes or suitable ducts or in any other approved manner while crossing the track.

iv) Cable laid across the track must be 1.0 meter (minimum) below the rail flanges.

v) No digging shall be done below the sleepers. Digging work while crossing a track shall be done between sleepers in the presence of a Railways representative.

8.3 A sketch No. SDO/CABLE LAYING/009 showing track crossing is enclosed **(Annexure-12)**.

9. Road Crossing

9.1 The cable is laid in concrete/GI/CI/PVC/DWC-HDPE pipes, suitable ducts or in any other approved manner while crossing the road at the depth of 1 meter from the ground level. It shall extend 1 meter (minimum) on each side of the road keeping in view the future increase of width of the road.

9.2 When crossing roads, it is necessary to lay the cables in such a manner as to avoid the necessity of bending the cable sharply and minimise the excavation of road surface as far as possible.

9.3 The crossing of main roads often involves difficulties, especially if traffic is heavy. Precautions to avoid accidents to workmen, pedestrians and vehicles shall be taken. On minor roads, which can be temporarily closed to traffic it is possible to open up across the entire width of the road, pipes shall be installed quickly in the cutting, which is then filled in there by reducing to a minimum the time for which the road is closed.

9.4 Some roads, which are broad, may be opened for half their width allowing the other half for use of traffic, pipes are laid, trench filled in the first half and the other half opened up after the first half is opened half is linked with those laid in the first half.

9.5 Whenever a cable is laid across an important road, particularly one with a special surface, it is good investment to provide for future expansion. Either the following methods may be adopted:-

(a) The size of the pipe shall be so chosen that provision for laying few cable is future is kept in view. Pipes having diameters ranging from 100 to 200 mm are suggested, or

(b) A spare pipe may be laid, through which a cable can be drawn when required. It will be advantageous to leave a lead wire of G.I. wire in the pipe for drawing the cable in future.

9.6 A separate pipe of suitable dia. shall be used for telecommunication cable.

9.7 A sketch No. SDO/CABLE LAYING/010 showing road crossing is enclosed **(Annexure-13)**.

10. **Cable laying on bridges/culverts**

10.1 Wherever practical, the cable may be taken underground across the drain bed at a suitable depth for crossing small culverts with low flood level. A sketch No. SDO/CABLE LAYING/011 showing cable laying on culverts with low flood level is enclosed **(Annexure-14)**.

10.2 Where cable may not be taken underground across the drain bed, cable shall be taken on the culvert through GI/DWC-HDPE pipe of suitable sizes. A sketch No. SDO/CABLE LAYING/012 showing cable laying on culverts with high flood level is enclosed (**Annexure-15**).

10.3 When cables have to cross a metallic bridge, they shall be placed inside a metallic trough which may be filled, as an anti-theft measure, with sealing compound. The cable shall be supported across the bridge in a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent of 2 to 3 meters shall be made available at the approaches of bridge. A sketch No. SDO/CABLE LAYING/013 & 014 showing cable laying on metallic bridges is enclosed (**Annexure-16 & Annexure-17**).

10.4 In case of arch bridges, cable shall be taken through GI/DWC-HDPE pipes on top of the arch adjoining the parapet wall. The pipe shall be covered with ballast. A sketch No.

SDO/CABLE LAYING/015 & 016 showing cable laying on arch bridges is enclosed (**Annexure-18 & Annexure-19**).

10.5 Concreting of 50 mm shall be done throughout from entry/exit end of cable up to diversion point including slope on either side. The entry and exit ends of the cable from the pipe to the diversion point of the cable shall be concreted for 1 metre (minimum).

10.6 As the laying involves movement of a large number of staff over the bridge the line shall be blocked and flagman posted on other side. On a double line only the line near which the cable is being laid shall be blocked but care shall be taken to see that staff are aware of this and measures taken to prevent staff from straying on to the unblocked line.

10.7 Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation, pier of bridge to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

10.8 In order to prevent theft and miscreant activities on approach of cable to bridge/culvert where it is not possible to ensure adequate depth, concrete protection is proposed.

11. Laying near to sleeper

11.1 In places where cables are to be laid within 1 metre from sleeper end, digging beyond 0.50 metre shall be done in the presence of an official from Engineering Department, and the laying of the cable and refilling of trench shall be done with least delay. Laying may be undertaken under block protection as needed.

12. Jumper cables for track circuits

12.1 There are numerous instances of jumper cable cut due to Engineering staff working. Such instances can be minimized if jumper cable is tied with the nearest sleeper. This shall be done on wooden sleepers using iron clamps/hooks. On PSC sleepers jumper cable shall be tied using clamps. A sketch No. SDO/CABLE LAYING/017 showing arrangement of jumper cable is enclosed **(Annexure-20)**.

12.2 Where sleeper ends, cable shall be buried underground in the line of sleeper and taken to TLJB. Wherever required, cable may be laid in DWC-HDPE pipe.

12.3 Jumper cable shall be laid at least 0.5 metre below ground level excluding ballast depth.

12.4 Jumper cable shall be laid neatly in squared manner and shall not be kept in loose coils above the ground near TLJB.

12.5 Top surface of TLJB shall not be 1 feet above rail level.

13. Cable markers

13.1 Cable markers wherever provided shall be placed at 30-40 metre interval and at diversion points.

13.2 There are three types of cable markers in use in different Zonal Railways:-

(a) Cast iron Tablet type cable markers.
(b) Concrete cable markers.
(c) Electronic Markers

13.3 Concrete cable markers can be adopted where RCC ducts are used or area is prone to theft. Concrete markers are projected above surface level for at least 300 mm.

13.4 A sketch No. SDO/CABLE LAYING/018, 019 & 020 showing cable marker is enclosed **(Annexure-21, Annexure-22 & Annexure-23)**.

14. Storing & transportation of cable

14.1 Cable drums shall not be stacked on flat side. Suitable stoppers shall be placed for stability.

14.2 Cable drums shall have easy access for lifting and moving.

14.3 When rolling the cable drum either for unloading or transportation, the drum shall always be rotated in the direction of the 'arrow' which is marked on the drum.

14.4 The drums shall not be rolled over objects that could cause damage to the protective battens of the cable.

14.5 When unloading is carried out from the vehicle the drum shall not be dropped on the ground directly to avoid damage due to impact. Fork lifter or ramp shall be used.

14.6 During all stages of storage, it is essential that the ends of the cable are effectively sealed by end cap or in any other approved manner to avoid water entry into the cable.

14.7 It is desirable that cable drums are stored in covered shed to protect against direct exposure to sun.

15. Paying out the cable

15.1 For paying out cables, the cable drums shall be mounted on cable wheels. It shall be ensured that no kink is formed while paying out the cable. A sketch No. SDO/CABLE LAYING/021 showing method of unrolling cable is enclosed **(Annexure-24)**.

15.2 The drum on the wheel shall be brought to one end of the trench and the end of the cable freed and the cable shall be laid along the trench.

15.3 The cable duct shall be brought as close to the cable trench if possible. The cable drum shall clear the ground by 5 to 10 cm.

15.4 The wooden battens on the drums shall be carefully removed shortly prior to laying and before the drum is mounted on the jack.

15.5 A party of labourers shall move along the trench carrying cable at suitable intervals so that cable is not damaged due to dragging along the ground or bent unduly.

15.6 The in-charge of cable laying shall ensure proper synchronization of all labourers for smooth laying.

15.7 In cases where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.

15.8 In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.

15.9 Whenever mechanized equipment is used, the work shall be carried out by a trained operator under the supervision of SSE/SE/JE (Signal) in-charge of the work.

15.10 Where the cable drum is in damaged condition the cable may be placed on a horizontal revolving platform and the cable paid out in the same manner as given in paras above.

15.11 Paying out of cable shall be done by rotating the cable drum and not by pulling the cable with excessive force.

15.12 Wherever flaking of cable is required, it shall be done by making a succession of loops in the form of Figure ‘8’, these loops being disposed on top of each other to avoid tangling of cable. Figure of ‘8’ flaking shall only be carried out under the direct supervision of an experienced official.

16. Laying in monsoon season

16.1 It is not advisable to lay cables in monsoon when the precipitation is heavy. The trenches will be inundated and visual inspection of the bedding of the trench will be rendered difficult. Threading the cable in pipes will also be more difficult.

16.2 When however cable laying is necessary during the monsoon season, the cable ends shall be inserted in a pipe sealed at one end and the pipe buried. Termination work shall be started only when there is likelihood of a clear weather for three or four days.

17. Entry of cable at cabin, relay room, location boxes etc.

17.1 All cable entry points in cabin, relay room, battery room, SM's room, location boxes, location huts, junction boxes, etc. must be closed with suitable masonry works, sand covered and plastering to prevent entry of rats etc. RCC slab shall be provided on the cable pit of cabin and relay room/station.

17.2 Cable shall be protected on both sides up to a distance of 10 metre beyond building line of cabin, relay room, battery room, SM's room. In case of location boxes, location huts, junction boxes etc. cable may be protected for 1 metre on each side.

17.3 Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation/masonry to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

18. Cable termination

18.1 The cable termination of signalling cables shall be undertaken by providing suitable location boxes/junction boxes on approved type termination.

18.2 All the core of the cable (used or spare) shall be terminated on approved type termination in cabin/SM's office or apparatus cases. Each core so terminated will be provided with identification ferrules with letters or/numbers embossed on them as per requirement of circuitry.

18.3 Termination of signalling cable on CT rack in relay room and in location boxes shall be done duly using identification marking on cable and on conductors/terminals. This will enable easy identification of conductors in case of any failures or cable disconnections

or cable cut done by outsider/ miscreants. A proper marking and termination practice ensures quick and easy restoration during failures.

18.4 For quad cable, jointing may be done as per instructions of Telecom Directorate of RDSO. For jointing of signal cable in straight portion arrangement shall be issued by RDSO separately.

19. Testing of cable

19.1 Before the cable is laid in the trench, a visual inspection of cable shall be made to see that there is no damage to the cable. It shall be tested for insulation and continuity of the cores. Thereafter, the cable shall be laid into the trench. Record of insulation and loop resistant must be maintained.

19.2 Testing of all main and tail cables after laying of the cable in trenches and also after termination in apparatus cases, in boxes and relay room shall be done.

19.3 Any defect noticed during the testing after laying the cable the same will be replaced.

19.4 All conductors in signalling cables must be tested for their insulation in dry weather every year as per instructions in para 20 below. A comparison of the test results between successive tests carried on a cable under similar conditions will give an indication of the trend towards deterioration of the insulating material over a period of time. If a sudden fall in insulation is observed, the cause shall be investigated and immediate steps taken up to repair or replace the cable.

19.5 In addition to the regular testing of cables in dry weather, random tests in wet weather may also be carried out, where considered necessary, to localise any sudden deterioration in insulation of cables.

19.6 After completion of any P.Way work in the vicinity of existing cable, testing of all cable may be undertaken to verify proper working of cable.

20. Instructions for insulation resistance testing of signalling cable

20.1 **General**

20.1.1 These instructions apply only to cables used for Railway Signalling and do not cover open line wires and internal wiring.

20.1.2 Insulation Resistance tests shall be made in such a manner that safe operation of trains is not affected. It shall be ensured that no unsafe conditions are set up by the application of test equipment.

20.1.3 All conductors in signalling cables must be tested for their insulation at the time of commissioning and thereafter in dry weather every year preferably during the same part of the year.

20.1.4 The insulation resistance tests shall be made when conductors, cables and insulated parts are clean and dry.

20.1.5 In addition to regular testing of the cables in dry weather, random tests in wet weather may also be carried out where considered necessary.

20.1.6 The conductors of the cables possess appreciable electrostatic capacity and may accumulate electrostatic charge. The cable conductors shall be shorted or earthed to completely discharge any accumulated charge (i) before connecting the insulation tester while commencing the test (ii) before the insulation tester is disconnected when the test is completed. This is in the interest of safety of personnel and protection of equipment

20.1.7 A 500V insulation tester shall be used for insulation testing. The fact that the cable has capacitance means that it has to be discharged before a measurement of the insulation resistance can be made. The insulation resistance shall therefore be recorded after the test voltage has been applied for one minute or so when the indicator of the insulation tester shows a steady reading.

20.1.8 Any metallic sheath or metal work of any rack or apparatus case shall be bonded to earth during test.

20.2 **Procedure**

20.2.1 Disconnect all cores of a cable at both ends. The disconnection may be made through links of approved type terminals, if provided.

20.2.2 Connect one terminal of the insulation tester to the conductor under test and other terminal to all the other conductors being bunched together and connected to earth.

20.2.3 Similarly test remaining conductors of the cable one by one.

20.2.4 Insulation Resistance so measured shall not be less than 5 mega ohms per kilometer at buried temperature. If the insulation resistance is found to be lower than 5 mega

ohms, the cause shall be investigated and immediate steps taken to repair or replace the cable to prevent any malfunctioning of the equipment and circuits.

20.2.5 The results of the insulation resistance tests shall be recorded in approved proforma. A comparison of test results between successive tests carried out on a cable under similar conditions will give an indication of the trend towards deterioration of the insulation resistance of the cable. If sudden fall in the insulation resistance is observed the cause shall be investigated and immediate steps taken to repair or replace the cable.

21. Supervision of cable laying

21.1 The work shall be supervised at site personally by an official of the Signal & Telecommunication Department not below the rank of a JE/SE/SSE (Signal).

21.2 Orders will be given by the Inspector in charge only. He will be assisted by others at vulnerable places to inform him of the position and possible danger.

21.3 All concerned staff shall have full knowledge of their duties and the material handled by them.

21.4 No work shall be started unless all types of materials, tools consumable materials and staff are available. Location boxes and junction boxes shall be in position. If the cable ends are left in the ground unattended, damage is likely to take place.

21.5 Following record shall be maintained by JE/SE/SSE in-charge of the work/section:-

21.5.1 Cable route plan

21.5.2 Cable distribution chart

21.5.3 Cable termination diagram

21.5.4 Cable Testing Record : Summary Sheet, including supply details etc. as per **Annexure 2**.

21.5.5 Cable Insulation Resistance Test Sheet as per **Annexure 3**.

22. Special requirements in 25 kV AC electrified area

22.1 Only unscreened cable shall be used.

22.2 Screened signalling cable may be used on signalling installations where screened cable is already in use and site condition demand its further use.

22.3 PVC insulated PVC sheathed and armoured unscreened cable to an approved specification (IRS-63) shall be used for carrying signalling circuits. Only approved type (IS-1554) power cable shall be used for signalling purposes.

22.4 The screened cable, if used, shall be PVC insulated, armored and to an approved specification IRS S-35.

22.5 The cable shall be so laid that it is not less than one meter from the nearest edge of the mast supporting the Catenary or any other live conductor, provided the depth of the cable does not exceed 0.5 meters. When the cable is laid at a depth greater than 0.5 meters, a minimum distance of 3 meters between the cable and the nearest edge of the O.H.E structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in concrete/heavy duty HDPE/Ducts or any other approved means for a distance of 3 meters on either side of the Mast. When so laid, the distance between the cable and the mast may be reduced to 0.5 meters. These precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.

22.6 In the vicinity of traction sub stations and feeding posts, the cable shall be at least one metre away from any metallic part of the O.H.E and other equipment at the substation, which is fixed on the ground, and at least one metre away from the substation earthing. In addition, the cable shall be laid in concrete or heavy-duty HDPE pipes/or other approved means for a length of 300 meters on either side of the feeding point. As far as possible, the cable shall be laid on the side of the track opposite to the feeding post.

22.7 In the vicinity of the switching stations, the cable shall be laid at least one metre away from any metallic body of the station, which is fixed in the ground, and at least 5 meters away from the station earthing. The distance of 5 meters can be reduced to one metre provided the cables are laid in concrete pipes/ heavy-duty HDPE pipes/ducts or any other approved means.

22.8 Where an independent Earth is provided for an OHE structure, i.e. where the mast is connected to a separate Earth instead of being connected to the rail, the cables shall be laid at least one metre away from the Earth.

22.9 Where there are O.H.E structures along the cable route, the cable trenches shall as far as possible, be dug not less than 5.5 meters away from the centre of the Track.

22.10 In a cable run, the number of circuits carrying 300V at any given instant shall not exceed three.

22.11 *Note: 300 V feed system shall not be used in future installations.

23. Drawings for cable laying

23.1 The sketches for cable laying in different areas, soils, bridges etc. are listed below and are enclosed. However, Railways may issue detailed drawings as per local requirement of Railways and number and size of cables required.

S. N.	Description	Drawing No.	Annexure
1.	TYPICAL MAIN CABLE DISTRIBUTION PLAN FOR DOUBLE LINE (4 LINES) PI STATION	SDO/CABLE LAYING/001	Annexure-4
2.	POSITION OF TRENCHES FOR CABLE LAYING	SDO/CABLE LAYING/002	Annexure-5
3.	CABLE TRENCH	SDO/CABLE LAYING/003	Annexure-6
4.	LAYING OF SIGNALLING CABLE & TELECOM/ POWER CABLE IN SAME TRENCH	SDO/CABLE LAYING/004	Annexure-7
5.	RCC DUCT 300 MM	SDO/CABLE LAYING/005	Annexure-8
6.	RCC DUCT 500 MM	SDO/CABLE LAYING/006	Annexure-9
7.	RCC DUCT 500 MM	SDO/CABLE LAYING/007	Annexure-10
8.	LAYING OF CABLES IN ROCKY AREA	SDO/CABLE LAYING/008	Annexure-11
9.	TRACK CROSSINGS	SDO/CABLE LAYING/009	Annexure-12
10	ROAD CROSSINGS	SDO/CABLE LAYING/010	Annexure-13
11	CABLE LAYING ON CULVERTS WITH LOW FLOOD LEVEL	SDO/CABLE LAYING/011	Annexure-14
12	CABLE LAYING ON CULVERTS WITH HIGH FLOOD LEVEL	SDO/CABLE LAYING/012	Annexure-15
13	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013	Annexure-16
14	CABLE TROUGH FOR METALLIC BRIDGES	SDO/CABLE LAYING/014	Annexure-17
15	CABLE LAYING ON ARCH BRIDGES	SDO/CABLE LAYING/015	Annexure-18
16	BRICK MASONRY CHANNEL FOR ARCH BRIDGE	SDO/CABLE LAYING/016	Annexure-19
17	ARRANGEMENT OF JUMPER CABLE	SDO/CABLE LAYING/017	Annexure-20
18	CI CABLE MARKER & CONCRETING	SDO/CABLE LAYING/018	Annexure-21
19	CI CABLE MARKER	SDO/CABLE LAYING/019	Annexure-22
20	CONCRETE CABLE MARKER	SDO/CABLE LAYING/020	Annexure-23
21	METHOD OF UNROLLING CABLE	SDO/CABLE LAYING/021	Annexure-24
22	RULE MADE OF PIPE FOR MEASURING TRENCH DEPTH	SDO/CABLE LAYING/022	Annexure-25

Annexure-1

JPO No. 1/SG/2004

(Issued under CRB's D.O. letter No. 2004/Sig/G/7 dated 17.12.2004)

JOINT PROCEDURE ORDER FOR UNDERTAKING DIGGING WORK IN THE VICINITY OF UNDERGROUND SIGNALLING, ELECTRICAL AND TELECOMMUNICATION CABLES

A. A number of Engineering works in connection with gauge conversion/doubling/third line are in progress on various railways, which require extensive digging work near the running track, in close vicinity of the working S&T cables carrying vital safety circuits as well as electrical cables feeding the power supply to Cabins, ASM room, RRI Cabin, Intermediate Block Huts (IBH) etc. Similarly, S&T organization under open line or construction units under CAO/C are executing various signalling and telecommunication works requiring digging of earth for laying of cables or casting of foundations for the erection of signal posts etc. RailTel are also executing the work of laying of quad cable and OFC on various Railways as a part of sanctioned works for exclusive use of Railways for carrying voice and data i.e. administrative and control communication, PRS, FOIS etc. or shared by RailTel Corporation of India Ltd. On certain sections digging is also required for laying of electrical cable and casting of foundation for the erection of OHE masts by Electrical Deptt. Generally, these works are executed by contractors employed .by these organizations.

B. However, while carrying out these works in the vicinity of working signalling, telecommunication and electrical cables, at times, cable cuts take place due to JCB machines working along the track or during the digging work being done by Contractors carrying out the Civil Engineering Works. Similarly, such cable cuts are also resulting due to works undertaken by S&T or Electrical deptts. Such Cable faults results in the failure of vital signalling and telecommunication circuits.

C. Henceforth, the following joint procedure shall be followed by Engineering, Electrical and S&T (and RailTel organization, wherever such works are being done by them) Officers of the respective divisions and by the Construction Organization, while carrying out any digging work near to existing signalling & telecommunication and electrical cables, so that the instances of cable cut due to execution of works can be controlled and minimized.

1. S&T Department (and RailTel, where they have laid the cables) & Electrical Deptts. shall provide a detailed cable route plan showing exact location of cable at an interval of 200m or wherever there is change in alignment so that the same is located easily by the Engineering official/contractor. This cable route plans shall be made

available to the DSE/DEN or Dy. CE/C as the case may be by Sr. DSTE/DSTE or Sr. DEE/DEE of the divisions or Dy. CSTE/C or Dy. CEE/C within a reasonable time in duplicate. DSE/DEN or Dy. CE/C will send copies to their field unit i.e. AEN/SE/P.Way & works.

2. Before taking up any digging activity on a particular work by any agency, Sr. DSTE/DSTE or Sr. DEE/DEE of the section shall be approached in writing by the concerned Engg or S& T or Electrical officer for permitting to undertake the work. After ensuring that the concerned executing agencies including the Contractor have fully understood the S&T and Electrical cable route plan shall permit the work in writing.

3. After getting the permission from S&T or Electrical Deptt. as the case may be, the relevant portion of the cable route plan shall be attached to the letter through which permission is issued to the Contractor by concerned Engg. official for commencement of work and ensuring that the Contractors have fully understood the cable route plan and precautions to be taken to prevent damage to the underground cables. The Contractor shall be asked to study the cable plan and follow it meticulously to ensure that the safety of the cable is not endangered. Such a provision, including any penalty for default, should form part of agreement also. It is advisable that a suitable post of SE (Sig) or SE (Tele) or SE(Elect.) shall be created chargeable to the estimates of doubling / Gauge conversion, who can help engg agencies in the execution of the work. However basic responsibility will be of the Department executing the work and the Contractor.

4. The SE (P.Way) or SE (Works) shall pass on the information to the concerned SE (Sig) or SE (Tele) or SE (Elect.) about the works being taken up by the Contractors in their sections at least 3 days in advance of the day of the work. In addition Engineering control shall also be informed by SE (P.Way) or SE (Works), which in turn shall pass on the information to the Test Room/Network Operation Centre of RailTel/TPC/Electrical Control.

5. On receiving the above information, SE (Sig) or SE (Tele) or SE (Elect.) shall visit the site on or before the date of taking up the work and issue permission to the Contractor to commence the work after checking that adequate precautions have been taken to avoid the damage to the cables. The permission shall be granted within 3 days of submission of such requests.

6. The name of the Contractor, his contact 'telephone number, the nature of the work shall be notified in the Engineering Control as soon as the concerned Engg. official issued the letter authorizing commencement of work to the Contractor. Test Room

be given a copy and Test Room shall collect any further details from the Engineering Control and shall pass it on to S&T/RailTel & Elect. officials regularly.

7. In case of works being taken up by the State Government, National Highway Authority etc., the details of the permission given i.e. the nature of work, kilometer etc. be given to the Engineering Control including the contact person's number so .that the work can be done in a planned manner. The permission letter shall indicate the contact numbers of Test Room/Network Operations Centre of RailTeI/TPC/Elect. Control.

8. Where the nature of the work taken up by the Engineering department is such that the OFC or other S&T cables or Electrical cables is to be shifted and relocated, notice of minimum one week shall be given so that the Division/RailTel/Construction can plan the works properly for shifting. Such shifting works shall, in addition, for security and integrity of the cables, be supervised by S&T supervisors / RailTel supervisors/ Electrical Supervisors.

9. The concerned SE(P.Way)/SE(Works)/SE(Sig)/SE(Tele)/SE(Elect.) or RailTel supervisors, supervising the work of the Contractor shall ensure that the existing emergency sockets are not damaged in view of their importance in providing communication during accident/emergency.

10. In case of minor nature of works where shifting of cable is not required, in order to prevent damage to the cable, the Engineering Contractor shall take out the S&T or optical fibre cable or Electrical cable carefully from the trench and place it properly alongside at a safe location before starting the earthwork under the supervision of SE (Sig) or SE (Tele) or SE (Electrical). The cable shall be reburied soon after completion of excavation with proper care including placement of the brick over the cable by the concerned S&T supervisors or Electrical Supervisors. However, the work will be charged to the concerned engineering work.

11. In all the sections where major project are to be taken up/going on RailTel/S&T Deptt. shall deploy their official to take preventive /corrective action at site of work.

12. No new OFC/Quad cable shall be laid close to existing track. It shall be laid close to Railway boundary as per extant instructions i.e. 1.0 m from the Railway boundary to the extent possible to avoid any interference with future works (doubling etc.). It shall be ensured in the new works of cable laying that the cable route is properly identified with electronic or Concrete markers. Henceforth, wherever cable laying is planned and before undertaking the laying work, the cable route plan of the same shall be got approved from the concerned Sr. DEN or Dy.

CE/Constn. to avoid possible damages in future. Such approvals shall be granted within 7 days of submission of the requests.

13. The works of excavating the trench and laying of the cable should proceed in quick succession, leaving a minimum time between the two activities.
14. Any damage caused to OFC/Quad cable or Electrical cable during execution of the work, necessary debit shall be raised on Engineering Department who shall bear the cost of the corrective action.
15. All types of bonds i.e. rail bond, cross bond and structure bond shall be restored by the Contractor with a view to keep the rail voltage low to ensure safety of personnel.
16. Above joint circular shall be applicable for construction as well as open line organization of Engineering, S&T & Electrical.
17. The S&T cable and Electrical cable route plan should be got approved from the concerned Sr. DSTE/ DSTE & Sr. DEE/DEE respectively, before undertaking the work and completion cable route plan should be finalised Block section by Block section as soon as the work is completed.

-sd-	-sd-	-sd-	-sd-
(R.S.Grover)	**(N.K.Goel)**	**(R.C.Sharma)**	**(R.Sundararajan)**
AM (Elec.)	**Adv (Sig)**	**AM (Tele)**	**AM (Works)**

Annexure-2

CABLE TESTING RECORD: SUMMARY SHEET

Cable No.		Cable Function	
Cable Size		Make	
Length		PO No. and date	
Between Locations		Inspection No. and Date	
Type of Protection		Spare Core Nos.	

SN	Date of Testing	Insulation Test Results		Ref. No. of Test Sheet*	Remarks and Signature
		Core to Core	Core to Earth		

*Tests sheets for Insulation and Loop resistance results in matrix format to be maintained separately for each cable in the cable testing register.

Annexure-3

CABLE INSULATION RESISTANCE TEST SHEET

Date of Meggering: **Signature**

(All figures in mega ohms unless otherwise specified)

No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
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1																														
2																														
No	E																													
1		1			4																									
2			2			5																								
3				3			6																							
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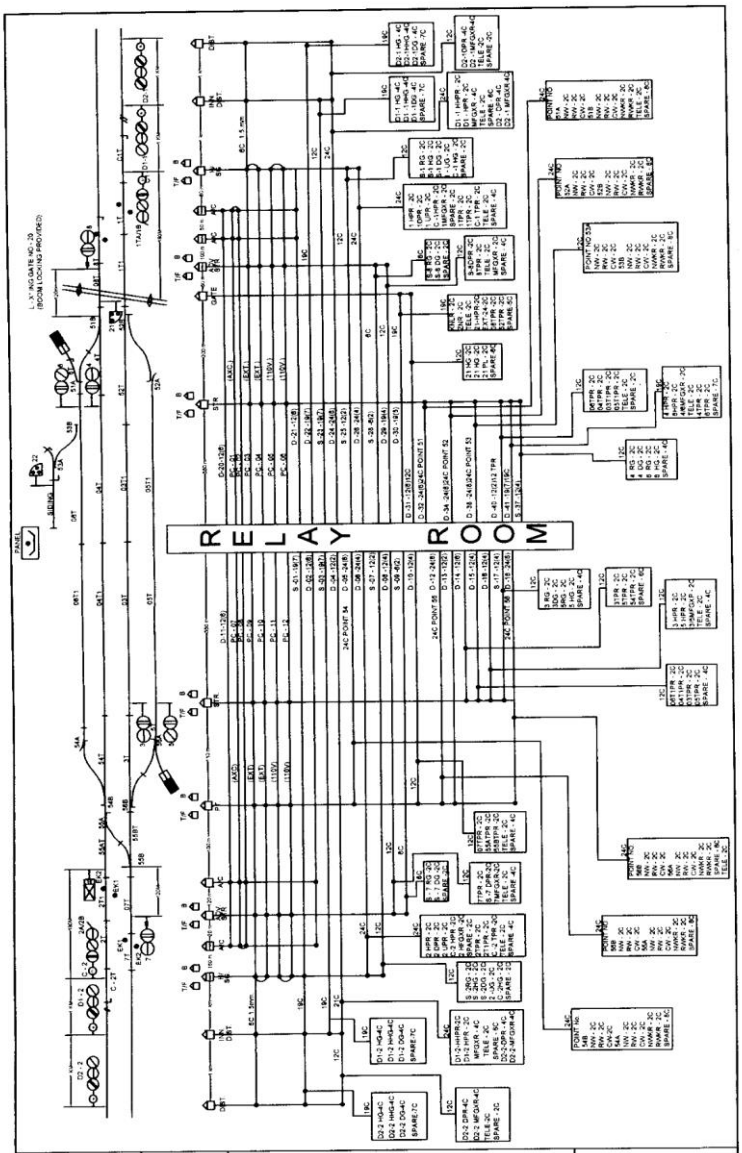
30																														30

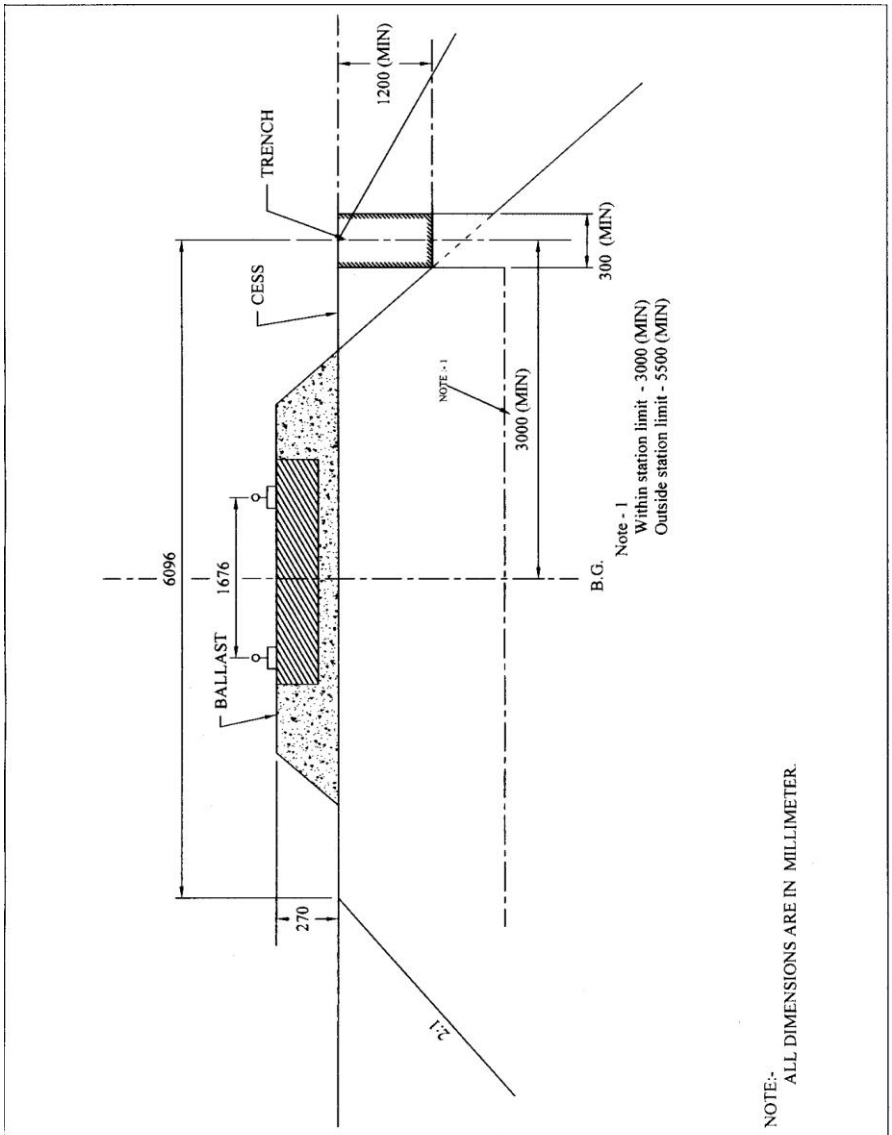
(All figures in mega ohms unless otherwise specified)

Date of Meggering: **Signature**

Annexure-4

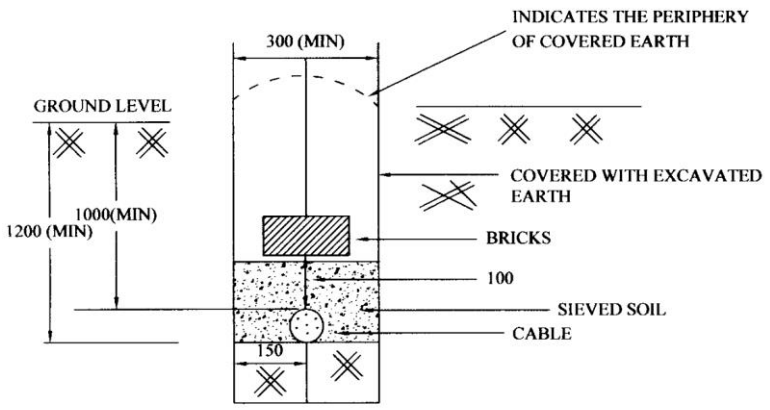

RELAY ROOM
CHECKED BY
JE/SE/SSE
TYPICAL MAIN CABLE DISTRIBUTION PLAN FOR DOUBLE LINE(4 LINE) P.I.STATION
SDO/CABLE LAYING/001
APPROVED BY
ADE
RDSO
DATE :-31-10-2011
NOT TO SCALE

Annexure-5

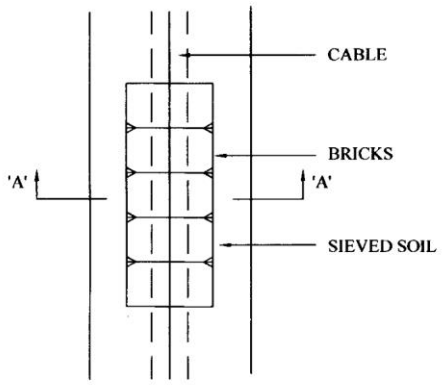


CHECKED BY	JE/SE/SSE	POSITION OF TRENCHES FOR CABLE LAYING	SDO/CABLE LAYING /002
APPROVED BY	ADE	R D S O	DATE : 31-10-2011
NOT TO SCALE			

Annexure-6



CUT SECTION 'AA'

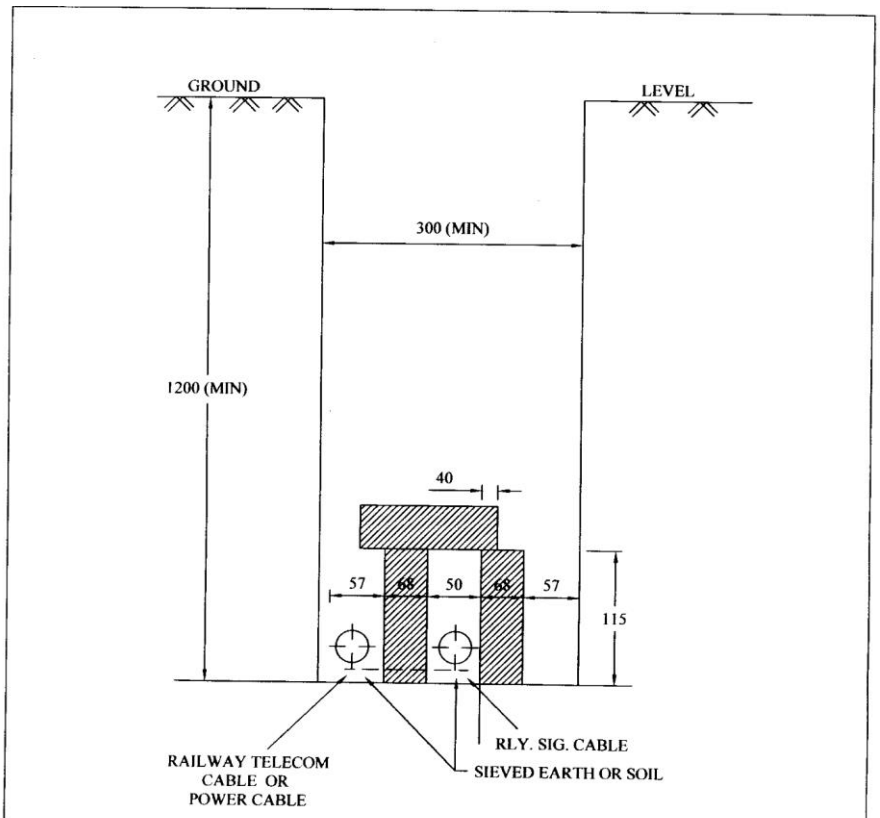


PLAN VIEW

NOTE :
1. ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	CABLE TRENCH	SDO/CABLE LAYING/003
APPROVED BY	ADE	R. D. S. O.	DATE : 31-10-2011
NOT TO SCALE			

Annexure-7

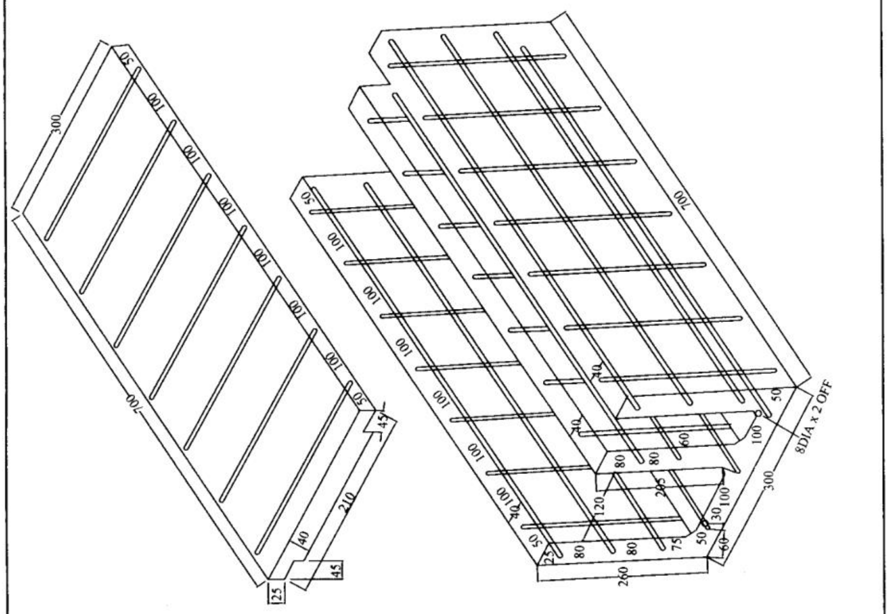


NOTE:

2. TELECOM CABLE/POWER CABLE TO BE LAID AWAY FROM THE TRACK
1. DIMENSIONS ARE IN MILLIMETRES

CHECKED BY	JE/SE/SSE	LAYING OF SIGNALLING CABLE & TELECOM/POWER CABLE IN SAME TRENCH	SDO/CABLE LAYING/004
APPROVED BY		R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-8

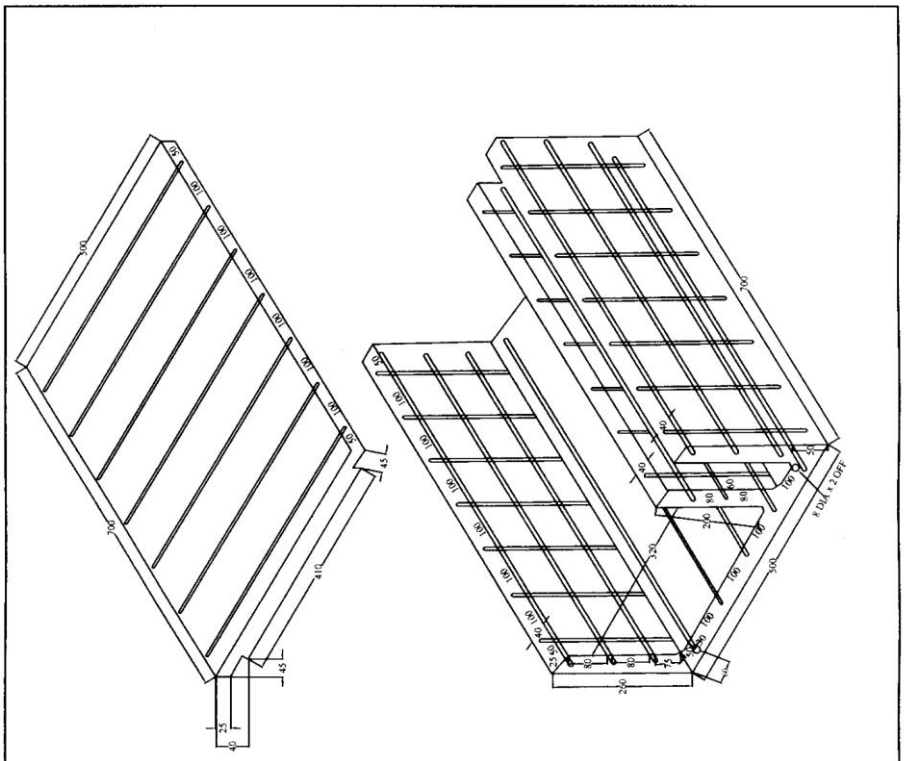


Note :-

1. TRUNKING AND CAPPING ARE SUITABLE FOR BURYING ADJACENT TO THE TRACKS IN TRENCHES WITH MINIMUM DEPTH OF 600 mm.
2. THE TRUNKING TO BE ALIGNED BY PUTTING AN MS ROD OF 8 mm DIA X 100mm LONG AS PER IS:432 PART (1)-1982 IN THE TWO HOLES PROVIDED.
3. 6.0 mm DIA HIGH STRENGTH DEFORMED STEEL BARS CONFORMING TO IS:11786 TO BE USED FOR REINFORCEMENT
4. M - 25 GRADE OF CONCRETE TO BE USED CONFORMING TO IS:10262 - 1982 AND IS:456 - 2000 - 10 mm SIZE COURSE AGGREGATE TO BE USED.
5. OPC OF 43 GRDE TO BE USED CONFORMING TO IS:8112 - 1989.
6. THE ACCEPTANCE TEST SHALL BE CONDUCTED IN A RECOGNISED LABORATORY AND THE COST OF THE TEST AS CHARGED BY THE LABORATORY SHALL BE BORNE BY THE CONTACTOR.
7. CURING SHALL BE DOBE AS PER THE IS: 456:2000.
8. DUCT MAY BE IN-SITU OR FACTORY MADE
9. ALL DEMENSION ARE IN MILLIMETER

CHECKED BY	JE/SE/SEE	RCC DUCT 300 MM.	SDO/CABLE LAYING/005
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

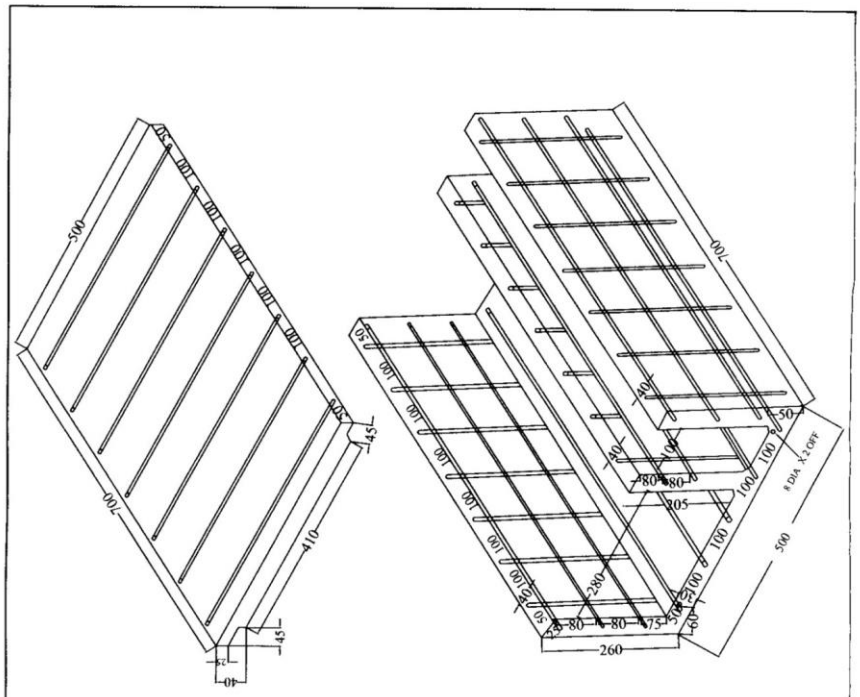
Annexure-9



Note :-
1. TRUNKING AND CAPPING ARE SUITABLE FOR BURYING ADJACENT TO THE TRACKS IN TRENCHES WITH MINIMUM DEPTH OF 600 mm.
2. THE TRUNKING TO BE ALIGNED BY PUTTING AN MS ROD OF 8 mm DIA X 100mm LONG AS PER IS:432 PART (1)-1982 IN THE TWO HOLES PROVIDED.
3. 6.0 mm DIA HIGH STRENGTH DEFORMED STEEL BARS CONFORMING TO IS:11786 TO BE USED FOR REINFORCEMENT
4. M - 25 GRADE OF CONCRETE TO BE USED CONFORMING TO IS: 10262 - 1982 AND IS:456 - 2000 - 10 mm SIZE COURSE AGGREGATE TO BE USED.
5. OPC OF 43 GRDE TO BE USED CONFORMING TO IS:8112 - 1989.
6. THE ACCEPTANCE TEST SHALL BE CONDUCTED IN A RECOGNISED LABORATORY AND THE COST OF THE TEST AS CHARGED BY THE LABORATORY SHALL BE BORNE BY THE CONTACTOR.
7. CURING SHALL BE DOBE AS PER THE IS: 456:2000.
8. DUCT MAY BE IN-SITU OR FACTORY MADE
9. ALL DEMENSION ARE IN MILLIMETER

CHECKED BY	JE/SE/SEE	RCC DUCT 500 MM.	SDO/CABLE LAYING/006
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-10

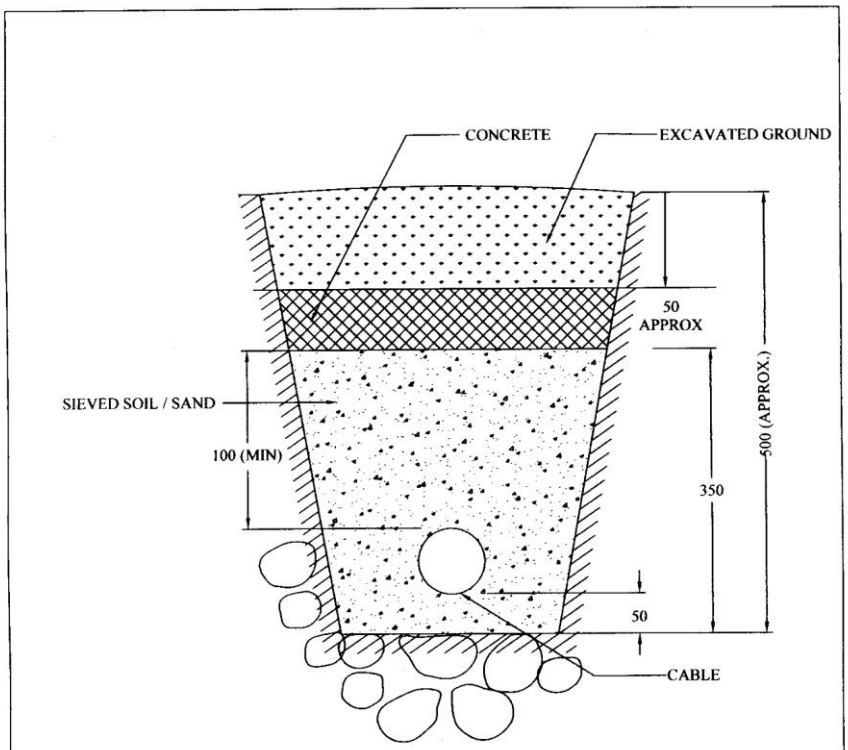


Note :-

1. TRUNKING AND CAPPING ARE SUITABLE FOR BURYING ADJACENT TO THE TRACKS IN TRENCHES WITH MINIMUM DEPTH OF 600 mm.
2. THE TRUNKING TO BE ALIGNED BY PUTTING AN MS ROD OF 8 mm DIA X 100mm LONG AS PER IS:432 PART (1)-1982 IN THE TWO HOLES PROVIDED.
3. 6.0 mm DIA HIGH STRENGTH DEFORMED STEEL BARS CONFORMING TO IS:11786 TO BE USED FOR REINFORCEMENT
4. M - 25 GRADE OF CONCRETE TO BE USED CONFORMING TO IS:10262 - 1982 AND IS:456 - 2000
5. - 10 mm SIZE COURSE AGGREGATE TO BE USED. OPC OF 43 GRDE TO BE USED CONFORMING TO IS:8112 - 1989.
6. THE ACCEPTANCE TEST SHALL BE CONDUCTED IN A RECOGNISED LABORATORY AND THE COST OF THE TEST AS CHARGED BY THE ABORATORY SHALL BE BORNE BY THE CONTACTOR.
7. CURING SHALL BE DOBE AS PER THE IS: 456:2000.
8. DUCT MAY BE IN-SITU OR FACTORY MADE
9. ALL DEMENSION ARE IN MILLIMETER

CHECKED BY	JE/SE/SEE	RCC DUCT 500 MM.	SDO/CABLE LAYING/007
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

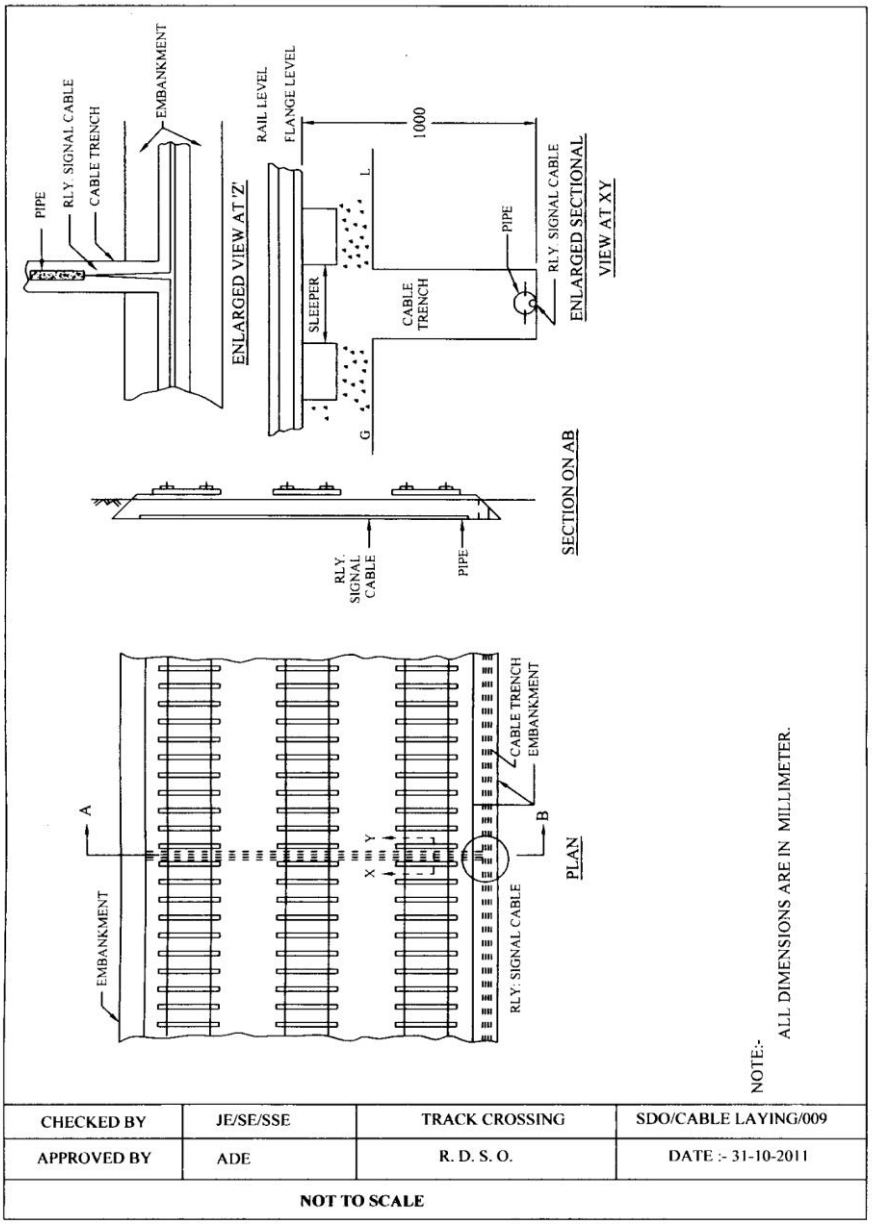
Annexure-11



NOTE:-
ALL DIMENSIONS ARE IN MILLIMETER.

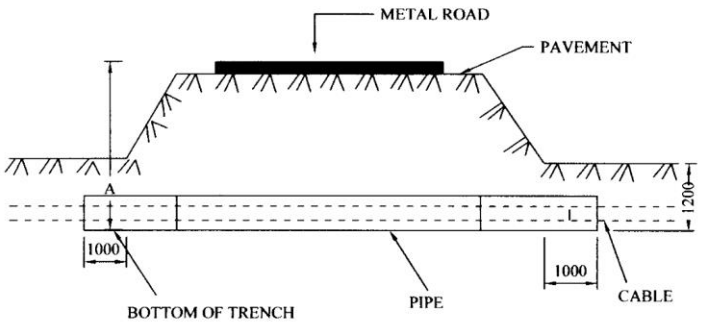
CHECKED BY	JE/SE/SSE	LAYING OF CABLES IN ROCKY AREA	SDO/CABLE LAYING/008
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-12



CHECKED BY	JE/SE/SSE	TRACK CROSSING	SDO/CABLE LAYING/009
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

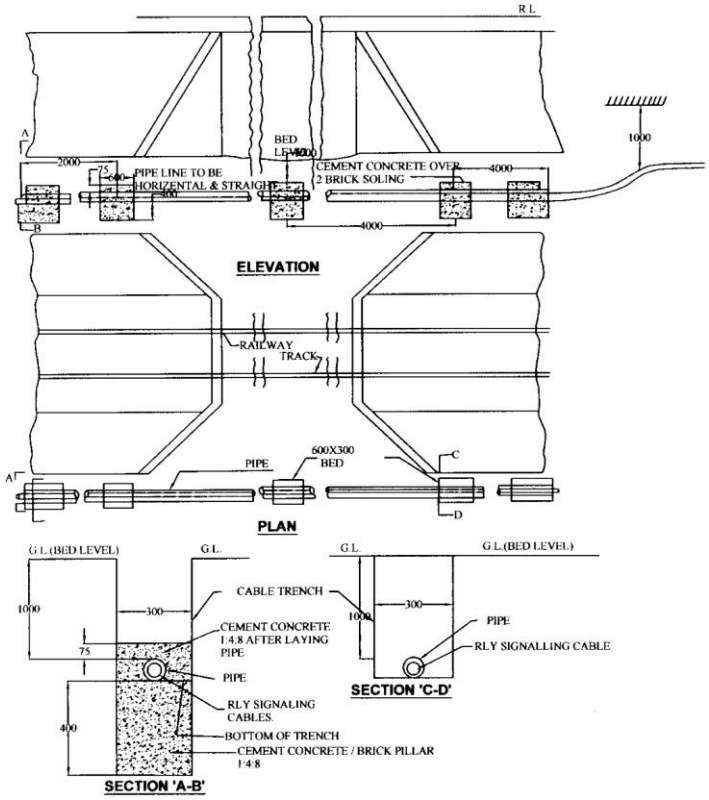
Annexure-13



NOTE:-
ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	ROAD CROSSINGS	SDO/CABLE LAYING/010
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-14

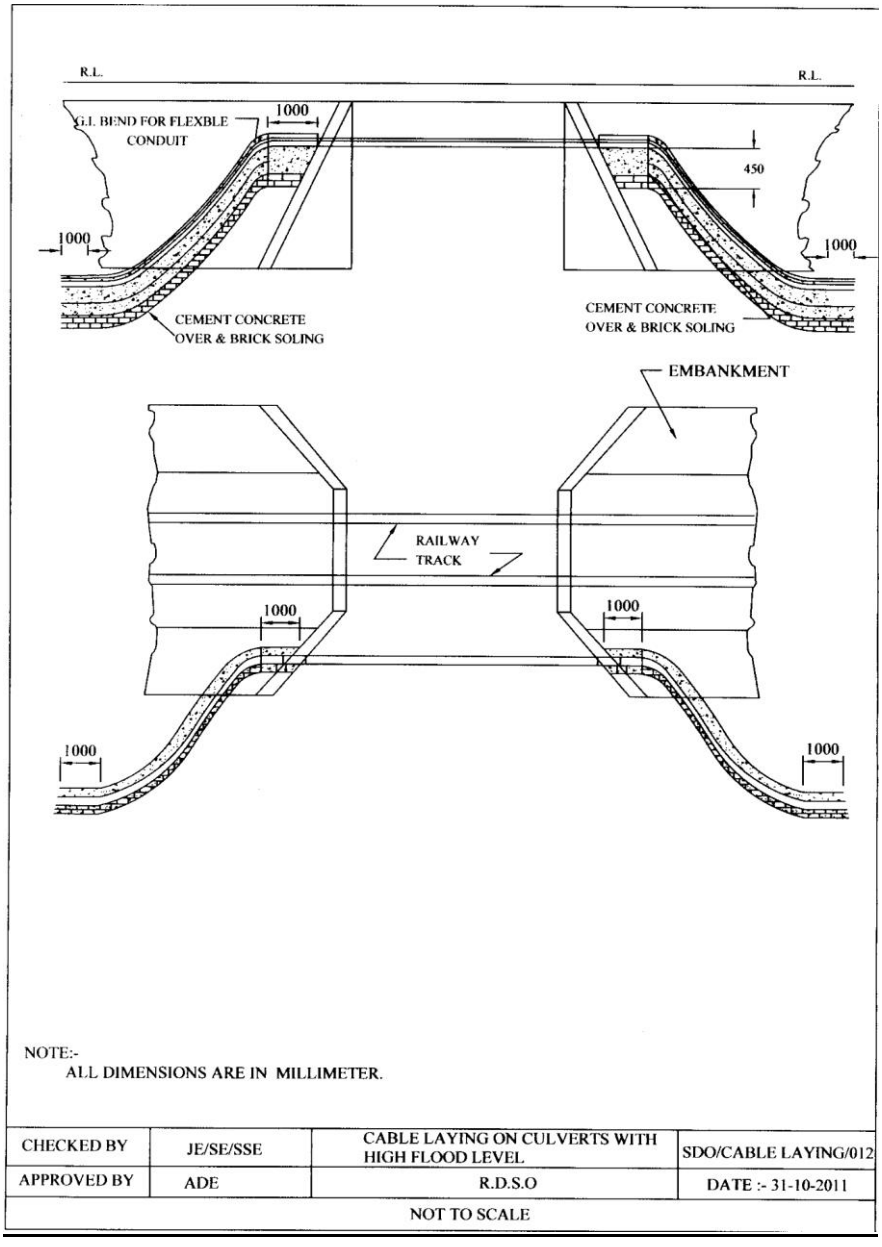


NOTE:-

ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	CABLE LAYING ON CULVERTS WITH LOW FLOOD LEVEL	SDO/CABLE LAYING/011
APPROVED BY	ADE	R.D.S.O	DATE :- 31-10-2011
NOT TO SCALE			

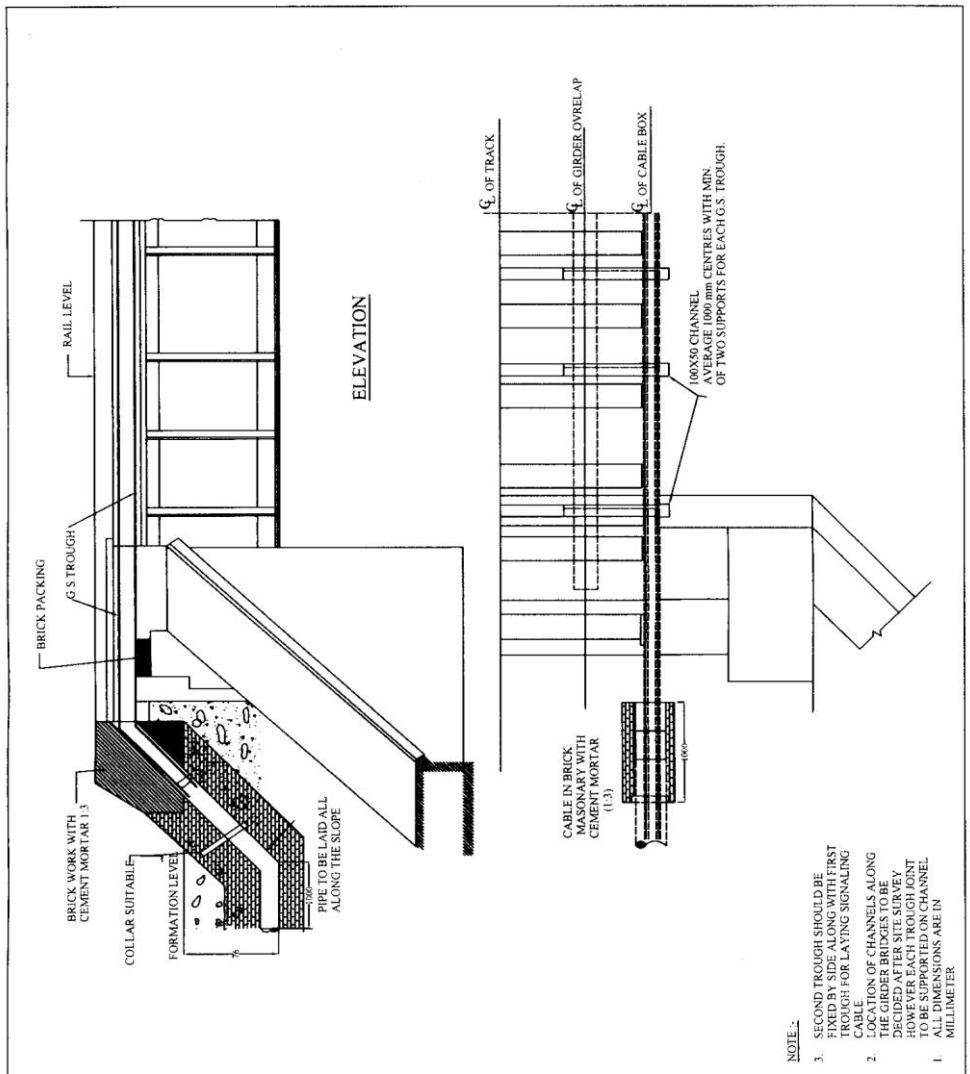
Annexure-15



NOTE:-
ALL DIMENSIONS ARE IN MILLIMETER.

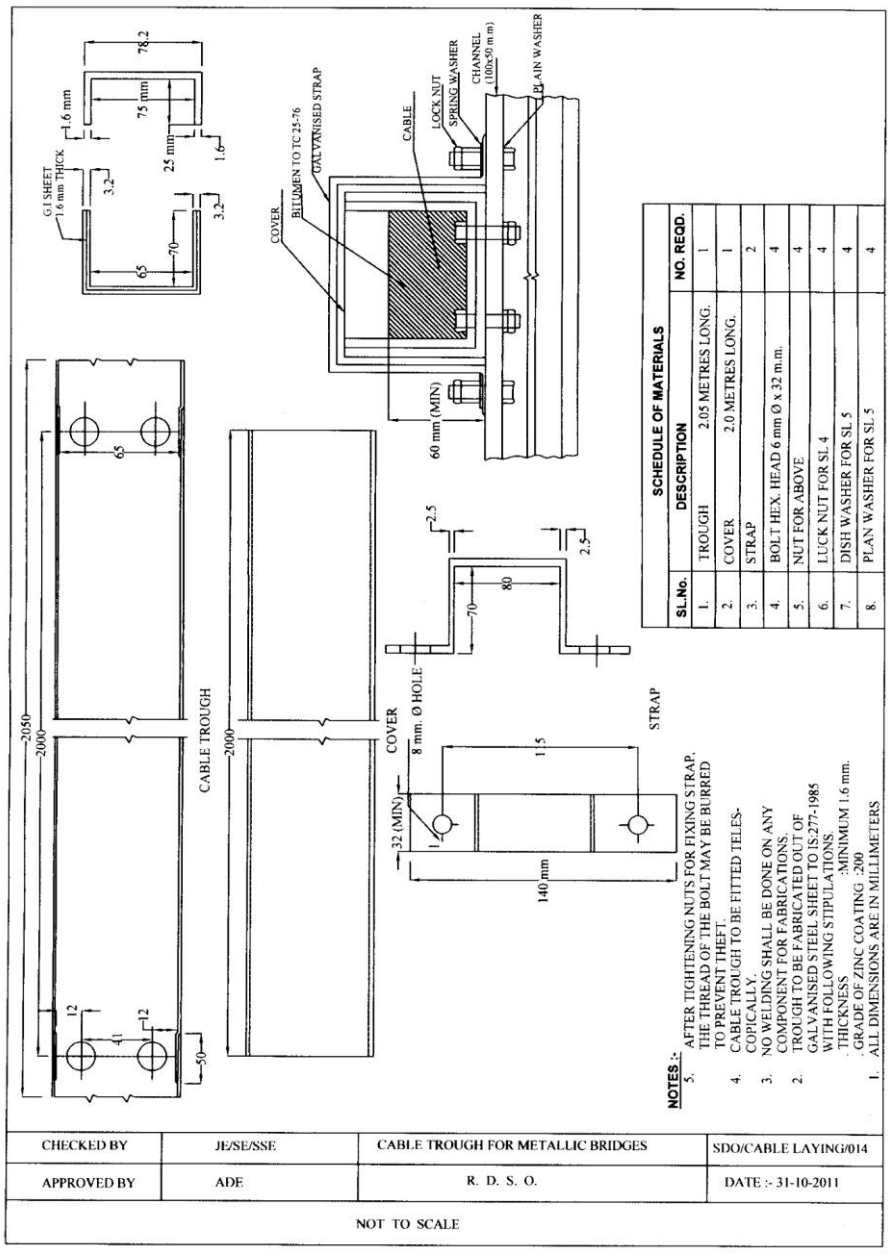
CHECKED BY	JE/SE/SSE	CABLE LAYING ON CULVERTS WITH HIGH FLOOD LEVEL	SDO/CABLE LAYING/012
APPROVED BY	ADE	R.D.S.O	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-16

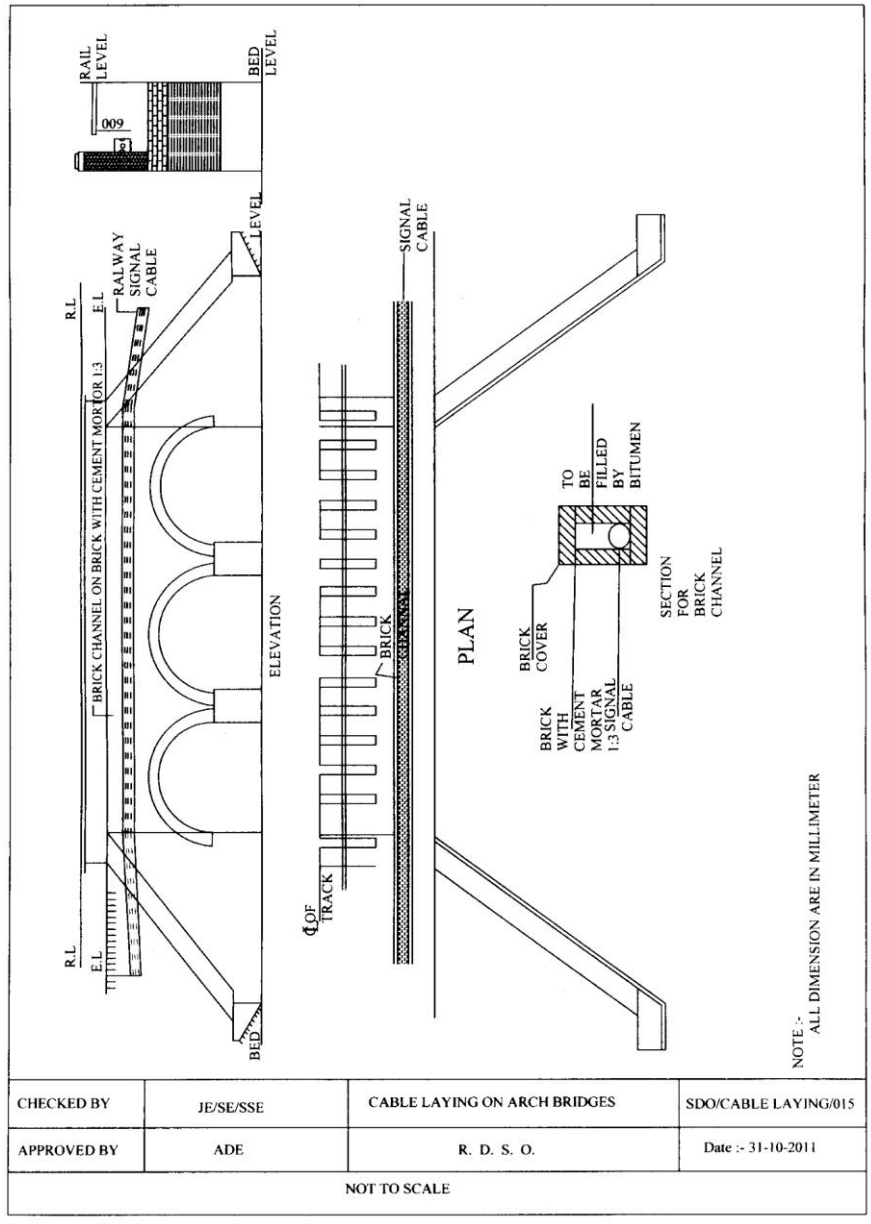


CHECKED BY	JE/SE/SSE	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-17

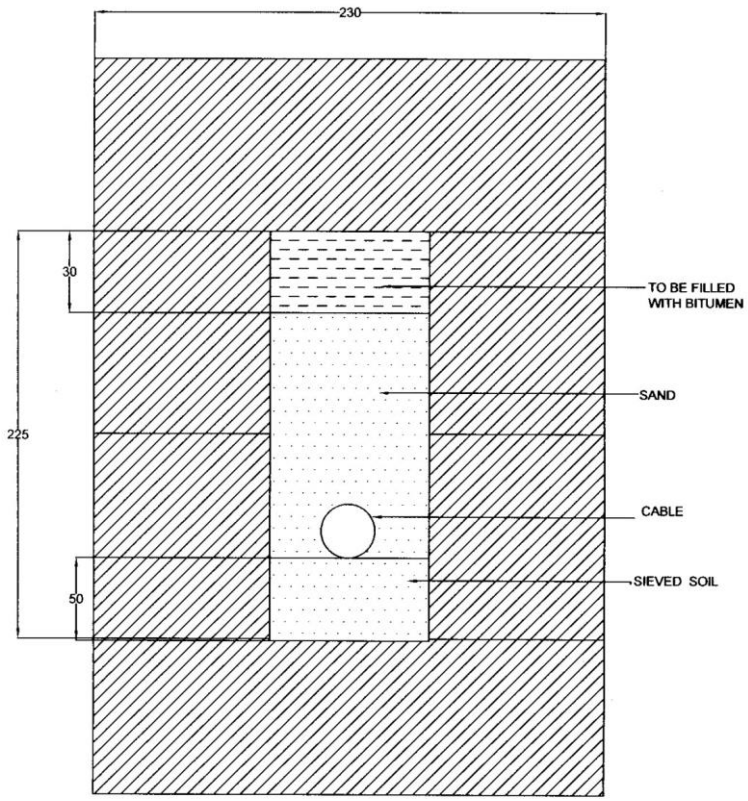

SCHEDULE OF MATERIALS
SL.No. DESCRIPTION NO. REQD.
1. TROUGH 2.05 METRES LONG. 1
2. COVER 2.0 METRES LONG. 1
3. STRAP 2
4. BOLT HEX. HEAD 6 mm Ø x 32 m.m. 4
5. NUT FOR ABOVE 4
6. LUCK NUT FOR SL 4 4
7. DISH WASHER FOR SL 5 4
8. PLAN WASHER FOR SL 5 4
NOTES :-
5. AFTER TIGHTENING NUTS FOR FIXING STRAP, THE THREAD OF THE BOLT MAY BE BURRED TO PREVENT THEFT.
4. CABLE TROUGH TO BE FITTED TELES-COPICALLY.
3. NO WELDING SHALL BE DONE ON ANY COMPONENT FOR FABRICATIONS.
2. TROUGH TO BE FABRICATED OUT OF GALVANISED STEEL SHEET TO IS:277-1985 WITH FOLLOWING STIPULATIONS.
THICKNESS :MINIMUM 1.6 mm.
GRADE OF ZINC COATING :200
1. ALL DIMENSIONS ARE IN MILLIMETERS
CABLE TROUGH
COVER
STRAP
8 mm. Ø HOLE
60 mm (MIN)
CABLE
LOCK NUT
SPRING WASHER
CHANNEL (100x50 m m)
PLAIN WASHER
BITUMEN TO TC 25-76
GALVANISED STRAP
G I SHEET 1.6 mm THICK
CHECKED BY JE/SE/SSE CABLE TROUGH FOR METALLIC BRIDGES SDO/CABLE LAYING/014
APPROVED BY ADE R. D. S. O. DATE :- 31-10-2011
NOT TO SCALE

Annexure-18



CHECKED BY	JE/SE/SSE	CABLE LAYING ON ARCH BRIDGES	SDO/CABLE LAYING/015
APPROVED BY	ADE	R. D. S. O.	Date :- 31-10-2011
NOT TO SCALE			

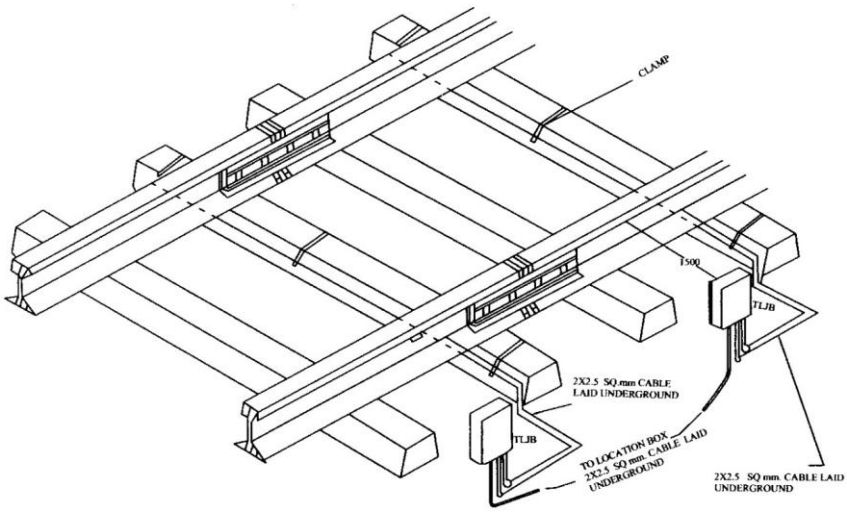
Annexure-19



NOTE :-
ALL DIMENTION ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	BRICK MASONRY CHANNEL FOR ARCH BRIDGE	SDO/CABLE LAYING /016
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-20

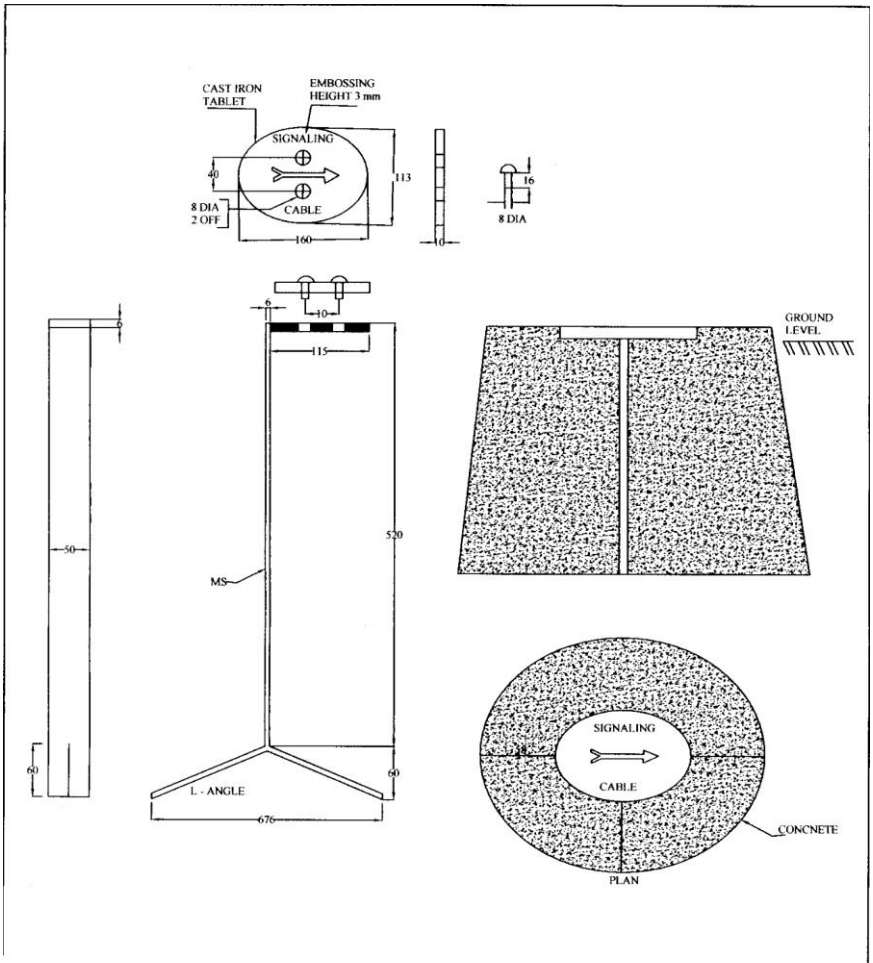


NOTE:-

ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	ARRANGMENT OF JUMPER CABLE	SDO/CABLE LAYING/017
APPROVED BY	ADE	R.D.S.O	DATE :- 31-10-2011
NOT TO SCALE			

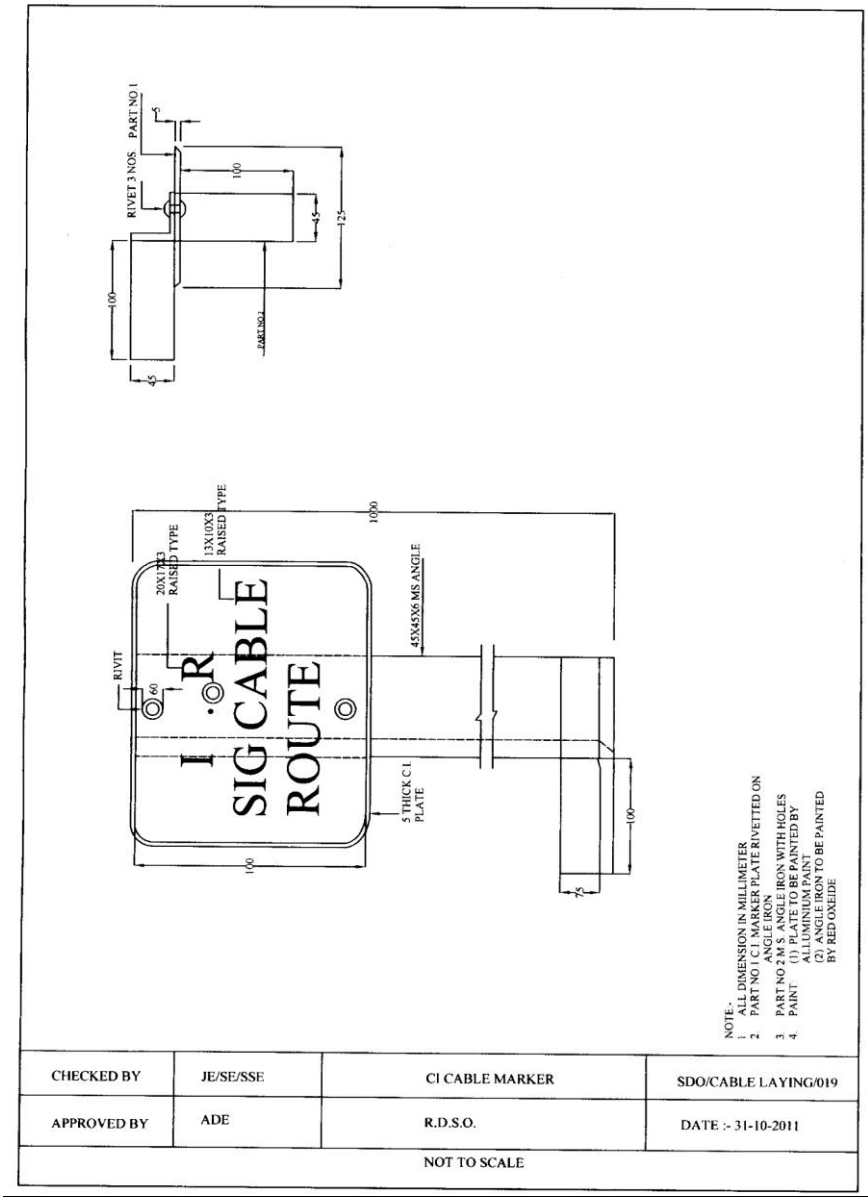
Annexure-21



NOTE :-
1. ALL DIMENSION ARE IN MM.
2. CAST IRON TABLET IS TO BE RIVETTED TO THE L - ANGLE ON THE 2 HOLES

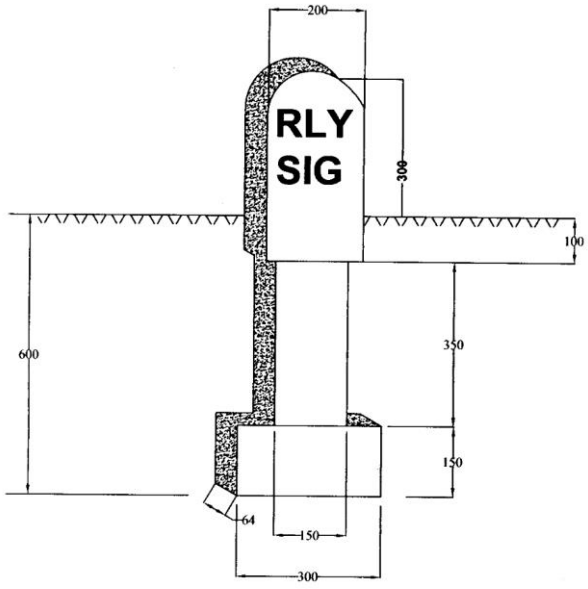
CHECKED BY	JE/SE/SSE	CI CABLE MARKER & CONCRETING	SDO/CABLE LAYING/018
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-22



CHECKED BY	JE/SE/SSE	CI CABLE MARKER	SDO/CABLE LAYING/019
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-23

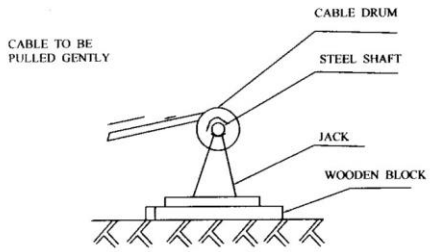


NOTE:-

1. ALL DIMENTIONS ARE IN MILLIMETER
2. PAINTED WHITE LETTERS ON RED BACKGROUND.
3. FOUNDATION CONCRETE OF 300 mm FROM THE BASE OF THE MARKER SHALL BE DONE AT SITE AT ALL PLACES WITH MIX 1:3:5.
4. COMPONENT CONCRETE SHALL BE OF M25 MIX AND WIRE MESH OF 1.5MM THICKMESS SHALL BE USED.
5. THE ENGRAVING OF "RLY" & "SIG" SHALL BE DONE ON BOTH SIDES OF THE MARKER.

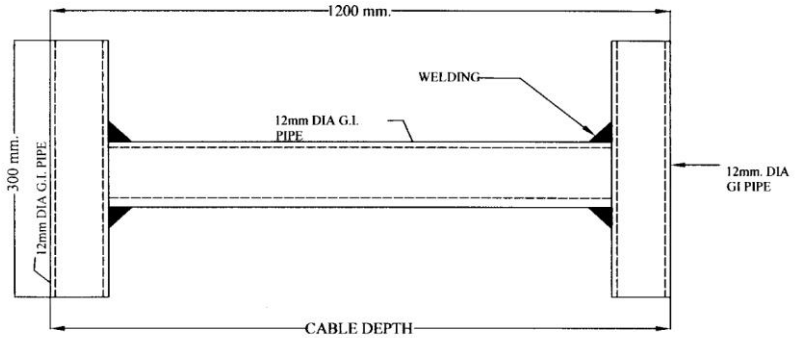
CHECKED BY	JE/SE/SSE	CONCRETE CABLE MARKER	SDO/CABLE LAYING/020
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-24



CHECKED BY	JE/SE/SSE	METHOD OF UNROLLING CABLE	SDO/CABLE LAYING /021
APPROVED BY	ADE	R.D.S.O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure-25



NOTE :-
ALL DIMENTION ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	RULE MADE OF PIPE FOR MEASURING TRENCH DEPTH	SDO/CABLE LAYING/022
APPROVED BY	ADE	R. D. S. O.	DATE :- 31-10-2011
NOT TO SCALE			

Annexure 10: DFCCIL's procedure for Cross Acceptance

PROCEDURE ORDER FOR CROSS ACCEPTANCE/APPROVAL OF SOFTWARE EMBEDDED ELECTRONICS SYSTEMS AND NEW/IMPORTED TECHNOLOGY PRODUCTS FOR RAILWAY SIGNALLING FOR DFCCIL

I. Preface

(a) These guidelines are meant for evaluating software embedded electronic systems and new/imported technology products for Railway signaling, which are already in use on a passenger carrying service anywhere in the world at speed more than 100KMPH, for adoption on DFCCIL using the concept of cross acceptance/cross approval. The procedure outlined in relevant CENELEC or any other equivalent standards to define and verify the safety requirements form the basis of these guidelines.

(b) These guidelines are applicable for evaluation of equipment against valid Contract Agreement with DFCCIL. These guidelines are to be applied as per requirement of respective Contract Agreement.

(c) These guidelines do not absolve the Contractor of his overall responsibility towards the relevant contract(s) in any manner whatsoever.

II. Object:

The object of these guidelines is to outline the process, activities, responsibilities and documentation necessary to carry out the Cross Acceptance / Cross Approval exercise by DFCCIL.

III. Responsibility of Safety Assurance:

(a) Safety clearance shall be given adopting the guidelines pertaining to Cross Acceptance/Cross Approval for adoption on DFC. This will include the System Hardware & Software Platform, Application software for implementing Safety Functions, Communication Interfaces, Input/Output modules, Power Supply (vital) Systems & other related equipment.

(b) This approval for a particular product/system will be requested by the manufacturer of the system, through the Contractor. The manufacturer will be responsible for submission & authenticity of the documentation. The documentation should be as per procedure laid down.

IV. Applications:

These guidelines shall be applied for evaluation & acceptance of all Software Embedded Electronic Safely Systems and New/Imported Technology Products for Railway Signalling for provision on DFC.

The Electronic systems/products are as under:

(i) Electronic interlocking, Digital Axle Counters and Train Protection and Warning System
(ii) STEP items to be supplied on account of STEP loan conditions

V. Procedure:

1. DFCCIL shall appoint an ISA for safety assessment of the equipment.

2. Contractor of the project shall ensure that manufacturer extends complete cooperation to DFCCIL/ISA/PMC.

3. Manufacturer shall depute his technical personnel for technical clarifications when required by DFCCIL/ISA/PMC.

4. The manufacturer/firm shall submit a Safety Plan to DFCCIL/ISA/PMC for evaluation of the system/equipment for Cross Acceptance/Approval. All documents shall be prepared in English language, checked & verified & marked appropriately indicating their version number, no. of alterations, etc.

5.

(a) Safety plan shall be prepared and submitted. This will include:-

(i) System description, which includes the system architecture / configuration, system design & safety principle adopted for hardware & software.
(ii) Safety Integrity Level of the system
(iii) Safety case

(b) Manufacturer shall check and verify that the system being offered meets the requirement of safety integrity laid down in the specifications.

(c) Safety Case is documentary evidence that the safety system is conforming to and complies with the laid down safety requirements for it. Safety Case will have to be prepared in accordance with relevant CENELEC or equivalent standards & submitted to DFCCIL/ISA/PMC as the case may be for assessment. Safety case shall consist of the following documents:

(i) Details of approval given by an authority responsible for clearing safety system for use on a passenger carrying service at speed of more than 100 KMPH anywhere in the world.
(ii) Standards to which the equipment have been developed and proposed to be supplied, i.e., CENELEC standard or any other equivalent standard adopted by that passenger-carrying Railway.
(iii) Details of agencies, which have done software/hardware validations.

(iv) Criteria adopted and assumption made.
(v) Documentation of these approvals, including trials, tests & measurements and simulation carried out.
(vi) Restrictions, precautions, conditions or limitations imposed while giving clearance and thereafter action taken by the manufacturer.
(vii) Calculations of Hazard rate or rate of unsafe side failure.
(viii) Details/documents related to installation, functional operation, maintenance & modifications. Part list, wiring diagram, cable requirement, and list of tools and measuring equipments along with specification shall be given.
(ix) Performance feedback duly authenticated and certified by various user Railways.

Name, Designation, Phone & FAX Nos. and address of the official certifying the performance feedback should be clearly available. This will include Mean Time Between Failures (MTBF) and Mean Time Between Wrong Side Failures (MTBWSF) and Mean Time To Repair (MTTR) figures as per format given in Annexure 'A'.

(x) Software & related instructions to configure the system initially as well as later due to changes in yard layout.
(xi) Complete history of development of the equipment shall be given. Modifications carried out in the system, if any, during last five years shall be listed. Date of each modification with brief reasons for undertaking modification and whether modification has got approval of original validation/approving agency. Version No. allotted after each modification shall be mentioned.
(xii) Type test (if required), Routine tests (which must be carried out on each equipment by the manufacturer) and acceptance tests (which are to be carried out on the equipment in the firm's premises before delivery) formats with test procedures and its significance for safety/reliability assessment of equipment. Sample routine test report/type test report/ factory acceptance test reports shall be submitted
(xiii) Details of climatic/EMI (Electro Magnetic Interference)/EMC (Electro Magnetic Compatibility) tests undergone by the equipment. Test reports of an accredited test laboratory (third party) shall be submitted. (The equipment shall also be subjected to environmental tests as per specification if not already done by some other reputed agency to the specified severity).
(xiv) Clause wise compliance statement to the specification and
(xv) statement whether system is suitable for DFC application or will require modifications. Updated history of application has to be submitted in the format as per Annexure 'B' for use in passenger carrying service at speeds of more than 100 kmph.

6. The Safety Integrity Requirement/Level for all vital applications for LC gates, station & Block Signaling & Interlocking systems / equipment / Track Circuits to be used on DFC, shall be SIL-4. In case, any system is required to have a SIL other than Safety Integrity Level-4 (SIL-4), DFCCIL approval shall be obtained before evaluating the system for Cross Acceptance.

7. The evaluation for Cross Acceptance shall normally be in compliance to the relevant specifications.

8. Provenness criteria of equipment usage of same Type/Make & Model/Version shall be as under: -

Sl. No.	**Category of Equipment/System**	**Minimum no. of Equipment**	**Equipment Hours in use**
1.	Digital Axle Counter	50	4,32,000
2.	TPWS (i) On Board Equipment (ii) Track Equipment Balise	25 100	2,16,000 8,64,000
3.	Electronic Interlocking	25	2,16,000
4.	Other items	100	8,64,000

Note 1: For all the above items: At least 20% of the equipment/system, with a minimum of 10, should be in continuous operation for a minimum period of 720 days.

Note 2: If the offered equipment has undergone minor hardware/software upgradation to improve functionality/safety of the equipment in recent past, then the equipment utilisation of the earlier version (prior to minor modifications) can be considered for the provenness. This decision of considering the earlier version for provenness shall be taken by DFCCIL. However, in such cases, a minimum of 10 (Ten) upgraded equipments should be in continuous operation for a minimum period of 180 days. Field trial of the equipment shall be conducted as detailed at Annexure C.

Note 3: STEP items to be supplied, as part of tied Japanese loan, if not deployed for commercial service anywhere, shall be subjected to type test and field trial as detailed at Annexure 'C'.

9. The manufacturer shall have adequate skilled and trained manpower with good expertise in relevant fields of manufacturing, installation, training, maintenance support etc. Details of these personnel with name, educational qualification, training undergone & experience shall be furnished at the time of approval.

10. Manufacturer seeking approval shall guarantee for supply of spares during life of the equipment & extend maintenance support**.**

11. The firm shall provide all necessary test facilities to DFCCIL representative in their premises in India and abroad as prescribed by their principals at the time of approval.

12. DFCCIL/ISA/PMC shall assess the safety case & prepare the assessment report clearly recommending whether the system/equipment is permitted for:-

    a. Type test and trials
    b. Field trials
    c. Use on DFC

13. The type tests and field trials, as required, shall be conducted as per Annexure "C'. After DFCCIL/ISA/PMC is satisfied with the documents submitted by the firm; results of the type test and field trial, if any; approval for the particular contract shall be given.

14. If any document of safety case is withdrawn or if any problem with the product arises, the supplier shall inform DFCCIL immediately. In such or any similar case DFCCIL may modify/withdraw the approval, as required.

Annexure'A'

Format for Performance Feedback

1. Name of System/Equipment :
2. Make :
3. Model/Version No. :
4. User Railway & Section :
5. Maximum Sectional Speed :
6. Arrange number of Trains per day :
7. Application of System/Equipment :
8. Problems faced and solutions evolved :
9. Failure data may be submitted as per format given below :

Location	No. of System / Eqpt.	Date of commi-ssioning	Total hours in use	No. of safe side failures	No. of unsafe failures	MTBF	MTBWSF	MTTR
Total								

Annexure'B'

Format for history of Application

Sl NO	Hardware version No.	Software version No.	Model No.	User Rly.	Station/ Section	No. of Eqpts. In use	In use from date

Annexure 'C '

Type test for signalling items

In case DFCCIL is fully satisfied with the consolidated report of the assessment, approval shall be given for type testing of prototype sample.

1. The type testing of prototype sample shall be undertaken to the satisfaction of DFCCIL.

2. 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.

3. The following tests shall constitute type tests :

   (i) Visual inspection tests
   (ii) Insulation resistance tests
   (iii) Card level functional and fail safety tests
   (iv) System level functional and fail safety tests
   (v) Computerized testing
   (vi) EMI/EMC tests
   (vii) Environmental / Climatic Tests
   (viii) System Diagnostic Tests
   (ix) System Software Test
   (x) Any other test deemed necessary

4. Manufacturer shall submit a comprehensive type test plan including procedure, type test format and expected results. The type test plan shall be finalized in consultation with DFCCIL / ISA / PMC.
5. Type tests shall be carried out at manufacturer's premises. Necessary testing equipments and competent man power shall be made available by the manufacturer.
6. Type test shall be carried out by DFCCIL representative / ISA.
7. Tests which cannot be carried out in house may be referred to independent test house of repute.
8. EMC / EMI tests may not be required if previous independent witness tests have been successfully carried out and reported by document.

Field trials for signalling items

1. The field trials shall be conducted to the satisfaction of the DFCCIL.

2. The field trials shall be held on Indian Railways / DFC as decided by DFCCIL. DFCCIL

shall coordinate with IR for this purpose.

3. The Contractor / Manufacturer shall make all arrangements for conducting field trials. This shall include; but not limited to; supply, installation, commissioning and monitoring of the equipment.
4. The trials shall be monitored in the following manner –

S N	Name of Division / Railway / Section	Name of station	Model and version no.	Date of installation	No. of failures*	Remarks

* Analysis of cause of failures to be attached.

Duration of field trial

SN	Item / Equipment	Initial trial	
		Number of equipments	Duration
1.	EI	01	180 days in parallel and/or standalone mode or a combination thereof as decided by DFCCIL
2.	DAC	01	180 days in parallel and/or standalone mode or a combination thereof as decided by DFCCIL
3.	TPWS	One (01) set of on Board equipment and ten (10) sets of track side system shall be installed and detailed trials shall be conducted for 180 days for compliance to specifications and performance monitoring.	

NOTE:

1. The number of equipments and duration can be suitably revised, as required, by DFCCIL.
2. DFCCIL shall decide if field trials and type test can proceed simultaneously or not.

**** End of Annexure 10 ****

Annexure 11: Cross Acceptance Responsibility Matrix

S. No.	Activity	Contractor/ Supplier/ Manufacturer	DFC	PMC	ISA	Comments
1.	Appointment of ISA		✓			
2.	Submission of Safety case & other documents to ISA for Cross Approval	✓				Copy to DFC & PMC
3.	Preparation of assessment report based on safety case & documents				✓	
4.	Review of assessment report (Part 1)			✓		
5.	Review & approval of Assessment report (Part 1)		✓			
6.	Submission of type test plan	✓				
7.	Validation of type test plan				✓	
8.	Review of type test plan			✓		
9.	Approval of type test plan		✓			
10.	Conduct of Type tests	✓	✓	✓		
11.	Submission of Type Test Report	✓				
12.	Review & recommendation of Type Test Report				✓	
13.	Recommendation of Type Test Report			✓		
14.	Approval of type test report					
15.	Supply, Installation & commissioning of Field Trial Equipment	✓				
16.	Monitoring of Field Trial	✓	✓	✓	✓	
17.	Submission of Field Trial Report	✓				
18.	Submission of Final Safety Assessment report				✓	
19.	Review of Final Safety Assessment report			✓		
20.	Approval of Final Safety Assessment report		✓			
21.	Factory Acceptance Test of Cross Approved Equipment		✓	✓		

NOTE: The Employer/ Engineer/ ISA shall respond to each of the above submissions from the Contractor/Supplier/ Manufacturer at the earliest. However, in this respect the review period specified in FIDIC Clause 5.2 shall not apply.