Bid Documents for

DESIGN AND CONSTRUCTION OF SIGNAL AND TELECOM WORKS FOR DOUBLE LINE RAILWAY INVOLVING TRAIN DETECTION SYSTEM, TRAIN PROTECTION & WARNING SYSTEM, ELECTRONIC INTERLOCKING IN STATIONS, AUTOMATIC SIGNALLING IN BLOCK SECTIONS, INTERLOCKING OF LEVEL CROSSING GATES, DISPATCH TELEPHONE SYSTEM, FIBER OPTIC COMMUNICATION SYSTEM, GSM(R) SYSTEM, DIGITAL ELECTRONIC EXCHANGE SYSTEM, MASTER CLOCK SYSTEM AND VIDEO SURVEILLANCE SYSTEM FOR REWARI – MAKARPURA SECTION AND TRAIN MONITORING AND DIAGNOSTIC SYSTEM FOR DADRI – JNPT SECTION INCLUDING TESTING AND COMMISSIONING ON DESIGN-BUILD LUMP SUM PRICE BASIS OF WESTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS CONTRACT
(Rewari – Makarpura of Phase 1 and part of Phase 2)

CONTRACT PACKAGE ST P-5

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VOLUME-III
EMPLOYER'S REQUIREMENTS
Section 9: Particular Specifications Part 2

TELECOMMUNICATION SYSTEM

Employer:

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

MINISTRY OF RAILWAYS
INDIA

PART 2

TELECOMMUNICATION SYSTEM

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LIST OF DEFINITIONS

In this Particular Specification, the following defined terms shall have the meanings ascribed here 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.
Corrective Maintenance	Maintenance performed to correct the occurrence of an equipment or system fault.
Dark Fiber	An available, un-switched optical fiber.
Line Replaceable Unit (LRU)	Equipment that can be replaced as a single complete unit and can be handled by a single person.
Main Line	Lines other than those within the ELMD.
Man Machine Interface (MMI)	The visual interface between the Controller and the control system. The MMI consists of the computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.
Mean Time To Restore (MTTR)	The average time to restore equipment, subsystems, systems to full functionality.
Mimic	A graphical representation of the railway and its global operating status.
Operating hours	Operating hours shall be 24 Hours all days.
Possession	Taking a section of the line out of service for engineering purposes.
Reliability	The measure of ability to rely upon equipment and systems to perform their intended function. The measure of reliability is MTBF.
Safety-Critical	Failure of the system, sub-system or equipment will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.
Stopping Position	The specified point within a station at which the train is to stop.
Sub-system	Any one of the six systems comprising the System; i.e. OFC system, GSM-R radio system, telephone system, dispatch telephone system, master clock system and video surveillance system.
Train Description	An alphanumeric sequence uniquely identifying a running train.
Train Operator/Driver	The person on the train responsible for its operation.
Workstation	The collection of processors, screens and input devices necessary to provide one Controller with the necessary System displays and Commands.
Pull-down Menu	A list of items displayed by clicking mouse, arranged in the downward direction.
Pull-up Menu	A list of items displayed by clicking mouse, arranged in the upward direction.

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ABBREVIATIONS

AUC/AC	Authentication Centre
ADM	Add Drop Multiplexer
ALARP	As Low As Reasonably Practicable
ASP	Audio and Selection Panel
AT	Auto Transformer
ATP	Automatic Train Protection
ATS	Auto Transformer station
BHCA	Busy Hour Call Attempt
BMS	Building Maintenance System
BS	Base Station
BSC	Base Station Controller
BSNL	Bharat Sanchar Nigam Limited
BSS	Base Station Sub system
BTS	Base Transceiver Station
BLSR	Bi-directional Line Switched Ring
CBS	Cell Broadcast Service
CC	Chief Controller
CCA/ACC	Assistant to Chief Controller
CCS	Centum Call Seconds
CCTV	Closed Circuit Television
CCU	Car Communications Unit
CD	Commercial Dispatcher
CENELEC	European Committee for Electro-technical Standardization
CER	Central Equipment Room
CI	Cell Identifier
CIF	Common Intermediate Format
CISPR	International Special Committee on Radio Interference
CLIP	Calling Line Identification Presentation
CILR	Calling Line Identification Restriction
C/I	Carrier to Interference Ratio
CLK	Clock System
CR	Card Reader
CS	Control Superintendent
CSMA/CD	Carrier Sense Multiple Access / Collision Detection
CSS	Central Security System
VMS	Voice Mail System
VRS	Voice Recording System
DCC	Depot Control Centre
DD	Depot (ELMD) Dispatcher
DDF	Digital Distribution Frame
DI	Digital Input
DID	Direct Inward Dial

DMO	Direct Mode Operation
DOD	Direct Outward Dial
DLT	Direct Line Telephone
DTS	Dispatch Telephone System
ECS	Environmental Control System
EIR	Equipment Identification Register
EIRENE	European Integrated Railway Radio Enhanced Network
E-LAN	Ethernet Local Area Network
ELMD	Electric Locomotive Maintenance Depot
eMLPP	Enhanced Multi level Precedence and Pre-emption Service
EN	European Norm
E&M	Ear and Mouth/Electrical & Mechanical
EoMPLS	Ethernet Over MPLS
EoS	Ethernet over SDH
EPL	Ethernet Private Line
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
ETSI	European Telecommunication Standards Institute
EVPL	Ethernet Virtual Private Line
FAT	Factory Acceptance Tests
FASW	Fast Ethernet Access Switch
FC	Facility Dispatcher
FEP	Front End Processor
FRS	Functional Requirement Specifications
FRU	Field Replaceable Unit
GCR	Group Call Register
GMSC	Gateway Mobile Switching System
GOS	Grade Of Service
GPRS	General Packet Radio Services
GPS	Global Positioning System
GUI	Graphical User Interface
GSM	Global System for Mobile communication
GSM-R	Global System for Mobile communication - Railway
HCS	Hundred Call Seconds
HDLC	High Level Data Link Control Protocol
HLR	Home Location Register
IAP	Integrated Audio Panel
ICT	Information and Communication Technology
ID	Identification
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMD	Integrated Maintenance Depot
IP	Internet Protocol

IR	Indian Railway
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunications Union – Telecommunication Standardisation Sector
ITU-R	International Telecommunications Union – Radio communication Sector
L2PT	Layer-2 Protocol Tunneling
LAN	Local Area Network
LAS	Link Assurance Signal
LC	Level Crossing
LCD	Liquid Cristal Display
LCP	Local Control Panel
LCX	Leaky Coaxial Cable
LDA	Location Dependant Addressing
LED	Light-Emitting Diode
MAC(Address)	Media Access Control Address
MDF	Main Distribution Frame
MEP	Mechanical Electrical Planning
MLPP	Multi Level Precedence and Pre-emption Service
MMI	Man Machine Interface
MMU	Machine Maintenance Unit
MPLS	Multiprotocol Label Switching
MORANE	Mobile Radio for Railway Network in Europe
MS	Mobile Subscriber
ms	Mili seconds
MSC	Mobile Switching Centre
MS-SPRING	Multiplex Section Shared Protection Ring
MTBF	Mean Time between Failures
NMS	Network Management System
NTP	Network Time Protocol
O&M	Operating and Maintenance
OA	Office Automation
OCC	Operation Control Centre
OCS	Overhead Contact System
ODF	Optical Distribution Frame
OFC	Optical Fiber Cable
OHE	Overhead Equipment
OMS	OTN Management System
OSI	Open System Interconnection
OTDR	Optical Time Domain Reflector
PABX	Private Automatic Branch Exchange
PAL	Phase Alternation by Line
PAT	Partial Acceptance Test

PC	Personal Computer
PCM	Pulse Code Modulation
PDH	Plesiochronous Digital Hierarchy
PI	Pulse Input
PLC	Programmable Logic Controller
PS	Particular Specifications
PSI	Power Supply Installation
PSS	Power Supply System
PSTN	Public Switched Telephone Network
PWE3	Ethernet Pseudo Wire
UPSR	Uni-directional Path Switched Ring
RCP	Radio Control Panel
RDW	Radio Dispatcher Workstation
REC	Railway Emergency Call
RF	Radio Frequency
RMON	Remote Monitoring
RTU	Remote Terminal Unit
SACFA	Standing Advisory Committee for Frequency Allocation
SAT	System Acceptance Tests
SC	Station Controller
SCADA	Supervisory Control and Data Acquisition
SCR	Station Controller Room or Assistant Station Master's Room
SDH	Synchronous Digital Hierarchy
SIL	Safety Integrity Level
SINAD	Signal to Noise and Distortion sensitivity
SM	Single Mode
SMPS	Switch Mode Power Supply SMS Station Management System
SMS	Short Message Service
SMSC	Short Message Service Centre
SNCP	Sub-network Connection Protection
SONET	Synchronous Digital Network
SP	Sectioning Post
SR	Space Radio
SRS	System Requirement Specifications
SSP	Sub Sectioning Post
STER	Signalling and Telecommunication Equipment Room
STM	Synchronous Transport Module
TBC	Train borne Communications
TC	Trafic Controller
TCCP	Train Cab Communication Panel
TCP/IP	Transfer Control Protocol / Internet Protocol
TD	Traffic Dispatcher

TDMA	Time Division Multiple Access
TETRA	Terrestrial Trunked Radio System
TER	Telecommunication Equipment Room
TFT-LCD	Thin Film Transistor – Liquid Cristal Display
TLC	Traction Locomotive Controller
TPC	Traction Power Controller
TRAU	Trans-coding and Rate Adaption Unit
TRX	Transceiver
TSS	Traction Sub station
TWS	Tower Wagon Shed
UMTS	Universal Mobile Telephone System
UPS	Uninterruptible Power Supply
UTC	Universal Time
VBS	Voice Broadcast Service
VCC	Vehicle Communication Controller
VDU	Video Display Unit
VGCS	Voice Group Call Service
VoIP	Voice over IP
VLAN	Virtual Local Area Network
VLR	Visitor Location Register
VMS	Voice Mail Service
VPWS	Virtual Private Wire Service
WAN	Wide Area Network
WPC	Wireless Planning and Co- ordination Wing of Ministry of Communication Government of India

1. INTRODUCTION

1.1 Scope and Purpose

1.1.1 This Specification covers the Design, manufacturing, delivery, installation, testing, commissioning and support for the Telecommunications System to be supplied under this Contract.

1.1.2 The Telecommunications System comprises of six subsystems including Fiber Optic Cable Communication System (OFC), GSM-R Radio System, Electronic Private Automatic Branch Exchange Telephone System, Dispatch Telephone System, Master Clock System and Video Surveillance System. This Particular Specification includes:

- Chapter 2 Scope of Works,
- Chapter 3 Performance Requirements,
- Chapter 4 Design Requirements,
- Chapter 5 to 11 of system requirements
- Chapter 12 Interface,
- Chapter 13 Verification, Testing and Commissioning,
- Chapter 14 Packaging, Shipping, Storage and Delivery,
- Chapter 15 Installation,
- Chapter 16 Operation and Maintenance Support,
- Chapter 17 Spares, Special Tools and Test Equipment,
- Chapter 18 Training,
- Chapter 19 Documentation, and
- Chapter 20 Programme Requirements.

1.2 Relevant Documents

1.2.1 This Particular Specification (PS) shall be read in conjunction with the General Conditions of Contract, Particular Conditions of Contract, the General Specification (GS), 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 the PS and any other standards or specifications quoted in the PS, the requirements of the PS shall prevail.

1.2.4 Notwithstanding the contents of Sections above, the Contractor shall always immediately seek advice from the Engineer in the event of conflicts between specifications.

1.3 Employers Drawings

1.3.1 Employer's drawings consist of Reference Drawings for typical stations as well as others as shown in Volume V of Employer's Drawings.

1.4 Overview of Telecommunication System

(1) For efficient railway management and operation, it is essential to have a well-organized telecommunication network covering strategic locations like OCC, stations, Electric Locomotive Maintenance Depot (ELMD) and maintenance depots, and it is equally essential to have reliable links between the strategic locations and moving trains or working staff along the railway track.

(2) The telecommunication system shall provide all necessary communication channels for carrying voice, data, and video signals for railway management and operation. Telecommunication channels shall be used for the telephone and radio systems and more than that for the control and supervision of the

train from the OCC, and data channels for traction power control and supervision from the OCC.

(3) The OFC backbone transmission network, which shall provide the necessary communication channels in the WDFC, shall be of adequate high quality, and shall have high reliability, availability and expandability.

(4) A private telephone exchange network (PABX) shall be constructed to provide basic telephone communication within the WDFC, it shall be used for management, personnel management, facility maintenance and train operation.

(5) The telecommunication system shall also consist of a Dispatcher Telephone System / direct line telephone communication network exclusively for the train operation and maintenance functions and shall constitute a non-blocking and vital communication link.

(6) The GSM-R radio system shall enable communication between the fixed strategic locations and the moving trains as well as the moving working personnel along the railway track. The radio system shall also be used for ELMD operation.

(7) A master clock system shall be provided to distribute time signal to all the clocks at stations, depots, and OCC.

(8) Video Surveillance System shall be installed at OCC.

1.4.1 Optical Fiber Cable Communication System

1.4.1.1 The Optical Fiber Cable Communication system (OFC) shall provide a common transmission backbone for the telecommunication & signalling Subsystems and other contracts of this project. The OFC shall have sufficient transmission bandwidth to cater for current operational needs of the WDFC Phase I as well as for future system expansion.

1.4.1.2 The OFC shall be equipped with a network management system to provide status monitoring, configuration, analysis and control of the various network elements.

1.4.1.3 The OFC consists of main optical fiber cable network, secondary optical fibre cable network, SDH transmission system and Data Network System. Equipment for ELMD shall be provided by RS P-7. It shall however be integrated in the SDH network of WDFC.

1.4.2 GSM-R Radio System

1.4.2.1 The Radio system shall comprise the following main functional elements:

(1) Train radio to OCC and vice versa
(2) Hand-portable to OCC and vice versa
(3) Hand-portable to DCC and vice versa
(4) Hand-portable to Hand-portable
(5) SCR to OCC and Hand-portables/ train mobiles and vice versa
(6) Railway Emergency Calls

1.4.3 Telephone System

1.4.3.1 The Telephone system shall provide a digital EPABX fixed telephone network in OCC, stations and ELMD. Requirement of ELMD is excluded from the scope of ST P-

5 as it shall be provided by RS P-7 contractor. ELMD system shall however interface with the WDFC system provided by ST P-5 as detailed in later chapters

1.4.3.2 The Telephone system shall include a Dispatch Telephone system to provide direct line telephone lines for train operation, traction power supply control and maintenance telephone lines for track, rolling stock, signalling and telecommunication. The system shall ensure instant, un-interruptible communication between key locations of the WDFC.

1.4.3.3 The EPABX network and DTS may be equipped with a common (or separate as applicable) network management system to provide user data management, alarm monitoring, performance monitoring and system monitoring.

1.4.4 Dispatch Telephone System Consoles

1.4.4.1 Dispatch telephone console shall be provided for each controller in OCC, ELMD, and stations. The DTS console in ELMD is excluded from the scope of ST P-5 as it shall be provided by RS P-7 contractor. ELMD system shall however interface with the WDFC system provided by ST P-5 as detailed in later chapters

1.4.4.2 Dispatch telephones shall be installed at strategic points, such as level crossings and traction substations, etc.

1.4.5 Master Clock System

1.4.5.1 Master clock system shall consist of two levels of hierarchy. First level is central level with synchronous signal from external. The second level is clock signal distributed to OCC, stations and ELMD, then fan out to clock display units. Requirements of ELMD are excluded from the scope of ST P-5 as it shall be provided by RS P-7 contractor. ELMD system shall however interface with the WDFC system provided by ST P-5 as detailed in later chapters.

1.4.6 Video Surveillance System

1.4.6.1 IP cameras shall be installed in OCC for security surveillance of the complete OCC complex.

1.4.6.2 VDU shall be provided for security controller in OCC as detailed in PS.

∗ End of Chapter 1 ∗

2. SCOPE OF THE WORKS

2.1 General Requirements

2.1.1 The Telecommunication System for WDFC to be designed, manufactured, supplied, delivered, installed, tested and commissioned by the Contractor under this Contract shall meet all the requirements as defined in the Specifications.

2.1.2 Requirements in respect of ELMD are excluded from the scope of ST P-5 contract except where specifically provided for in this PS.

2.2 Scope of Supplies

2.2.1 The scope of supply shall include all necessary hardware, software, firmware, accessories, materials and documentation. The detailed requirements shall be as given in this Particular Specification.

2.2.2 Contractor shall design, supply, install and commission metal cabin type Telecommunication Equipment Huts, at locations other than stations & OCC, of adequate size complete with air-conditioning and furnishing for housing GSM-R radio Base Station equipment, SDH/ADM equipment, networking equipment, batteries, battery charging equipment and equipment for level crossing gate telephone etc; The design details of the Telecom Equipment Hut(s) per Appendix 7 shall be submitted to the Engineer for review as part of the detailed design for OFC system. Re-locatable type cabins pre-furnished and prewired shall be preferred as quality of construction can be ensured. . The contractor shall interface with the CT P-1, CT P-2 & CT P-3 contractors and the Engineer for the space for the Telecom Equipment Huts (cabins) and the towers for the GSM-R radio system. Contractor shall interface with EM P-4 contractor for the AC power supply from the traction ATs.

2.2.3 Telecom Equipment Rooms complete with air-conditioning and telecom power supply rooms for batteries and battery chargers at all stations and OCC will be provided by the respective contractors of Packages CT P-1, CT P-2 & CT P-3 and are excluded from the ST P-5 contract. ST P-5 shall however provide portable fire extinguishers of adequate capacity, specifications and suitable for electrical and electronic equipment in each TER. and power supply room. Contractor shall interface with CT P-1, CT P-2 & CT P-3 contractors for requirement of these TERs and telecom power supply rooms and the space required for GSM® towers at all stations and at OCC.

2.2.4 Interface requirements with other contractors are given in chapter 12 and appendices 8 & 9.

2.3 Scope of Services

2.3.1 The detailed requirements of the services to be provided by the Contractor shall be as given in the General Specifications and this Particular Specifications.

2.3.2 Requirements in respect of ELMD are excluded from the scope of ST P-5 contract except where specifically provided for in this PS.

2.3.3 The scope of services to be performed by the Contractor shall include, but not be limited to the following:

(1) Design, manufacture, delivery, system assurance, installation, testing and commissioning of the Telecommunications System;
(2) Presentations, reviews and audit support as specified in the Specification;
(3) Project management of the implementation of the System;
(4) Quality and safety management;
(5) Overall site supervision and management;

(6) Decommissioning, removal and disposal of Temporary Works;
(7) Operation and maintenance support services;
(8) Preparation and submission of documentation;
(9) Training for Employer's Training Instructors, operations staff, maintenance staff and engineering staff;
(10) Recommendation and provision of spares, tools and test equipment;
(11) Interface management;
(12) Manpower resources; and
(13) Prototypes, mock-ups and simulation as required.

∗ End of Chapter 2 ∗

3. PERFORMANCE REQUIREMENTS

3.1 General

3.1.1 The Contractor shall ensure that all equipment and material used is able to meet the specified availability throughout its service life as required to minimise disruption to the railway operation and to minimise the maintenance costs.

3.1.2 The System shall be so designed as to have a minimum of 15 years of service life operating continuously. The life of all the cables including leaky coaxial cables (if used), telephone cables, RF cables, power cables, data cables and optical fiber cables shall not be lower than 25 years. Life of radio towers shall not be less than 40 years. Service life shall be counted from the commencement date of Defects Liability Period.

3.1.3 The system shall be designed to facilitate normal train and station operation, management of incidents and abnormal operations as well as of emergencies.

3.2 Reliability Requirements

3.2.1 The inability to perform a required function, the occurrence of unexpected action by the equipment, or the degradation of performance to below the required specifications shall constitute a failure.

3.2.2 The Contractor shall submit Mean-Time-Between-Failures (MTBF) figure for major equipment of each sub-system as specified in Chapters 5 to 11 of this Particular Specification. If higher MTBF figures are required to achieve the required level of System availability, the Contractor shall adopt suitably higher MTBF figures in equipment selection.

3.2.3 The Contractor shall submit Reliability Plan to the Engineer for review in accordance with RAMS Plan.

3.2.4 The Reliability Plan shall describe the analytical methods to be used during design and development to demonstrate compliance with reliability requirements and identification of reliability-critical items in the System offered.

3.2.5 The Reliability Plan shall identify a comprehensive list of reliability-related submissions such as specifications, standards, method statements, procedures, drawings and records to the Engineer for review.

3.3 Availability Requirements

3.3.1 Detailed availability requirements for individual sub-systems are given in Section 4 of relevant Chapters of this Particular Specification.

3.3.2 The Contractor shall submit calculations with reliability block diagrams for each sub-system to demonstrate the compliance with required availability figures. The availability calculation shall take all possible failure modes into consideration. The calculation shall be based on the Contractor's submitted equipment MTBF figures, MTTR figures and the configuration/designed architecture of each sub-system.

3.3.3 Equipment duplication, hot-standby protection, parallel-run, path diversity, etc. shall be adopted whenever necessary and appropriate to meet the required availability.

3.3.4 Error detection and correction mechanism shall be included in the communication links as appropriate depending on the nature and functional criticality of the data conveyed.

3.3.5 Switchover between redundant equipment, or between redundant routings, shall occur automatically and immediately upon failure and shall be transparent to the users. Toggling in switchovers shall be prevented.

3.3.6 The Contractor shall conduct analysis and propose methods, if any, for further improvement of the availability of each sub-system beyond the minimum required availability figures mentioned above.

3.4 Maintainability Requirements

3.4.1 The Contractor's response time during Defects Liability Period (DLP) shall not exceed 2 hours. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.

3.4.2 The Mean Time To Repair (MTTR) shall not exceed 2 hours. The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time on site, but shall exclude the response time.

3.4.3 All plug-in modules shall permit hot swapping so as not to affect the normal or emergency operation of the System.

3.4.4 The System shall be suitably designed to minimise the need for frequent preventive maintenance.

3.4.5 The System shall be so designed as to avoid the need for a total shutdown for preventive maintenance.

3.4.6 The System shall be so designed as to prevent failures or breakdown due to invalid or incorrect inputs.

3.4.7 Built-in self-diagnostics, power-up self-test and sufficient test points shall be provided in the System to minimise the time required to locate a fault.

3.4.8 All components, materials, software and supports required for repair and servicing of the System shall be available during the entire lifetime of the System.

3.4.9 The Contractor shall submit Maintainability Plan to the Engineer for review in accordance with RAMS Plan.

3.4.10 The Maintainability Plan shall describe the analytical methods to be used during design and development stages to demonstrate compliance with maintainability requirements specified herein and to identify the maintainability-critical items of the System.

3.4.11 The Maintainability Plan shall identify a comprehensive list of maintainability-related submissions such as specifications, standards, method statements, procedures, drawings, and records to the Engineer for review

3.5 System Safety Requirements

3.5.1 The Contractor shall perform the mandatory safety activities as detailed in Appendix 7 System Safety Management of the GS.

3.5.2 The Contractor shall support other Project Contractors with the provision of information and relevant analysis where the availability and usability of the Telecommunications System is a contributing factor to the overall system risk.

3.5.3 All Man-Machine-Interfaces shall be designed with the risk of Repetitive Strain Injury (RSI), eye strain and radiation-induced illness (both non-ionising and ionising radiation) taken into consideration.

3.5.4 The design of the System shall minimise the risk of fire.

3.5.5 The design of the System shall minimise the build-up of static, as well as the effects of static discharge during maintenance.

3.5.6 No toxic or asbestos-containing materials shall be used anywhere in the System.

3.6 Electromagnetic Compatibility (EMC)

3.6.1 The Contractor shall only use such frequencies and use such transmission parameters for radio communication as may be allocated for this application to WDFC by the Wireless Planning and Co-ordination Wing Ministry of communication Government of India (WPC), and which shall not cause electromagnetic interference to and from other radio communication systems operating in close proximity.

3.6.2 The Contractor shall ensure and demonstrate that the System is adequately protected against electromagnetic interference (EMI) among the systems of the WDFC. Particular attention should also be paid to additional requirements in grounding, bounding, shielding, filtering and cabling arrangement. The Contractor is required to conduct type tests as well as full EMC tests. Tests to be conducted shall include but not limited to satisfying the following standards:

(1) Overall compliance of EN 50121-1 & EN 50121-4 and

(2) Specific Standards of Immunity

1)	Electrostatic discharge	:	IEC61000-4-2
2)	Radio frequency fields	:	IEC61000-4-3,
3)	Electric fast transient/burst	:	IEC61000-4-4,
4)	Surge	:	IEC61000-4-5,
5)	Conducted RF	:	IEC61000-4-6,
6)	Power frequency magnetic field	:	IEC61000-4-8
7)	Pulse magnetic field	:	IEC61000-4-9
8)	Damped Oscillatory magnetic field	:	IEC61000-4-10
9)	Voltage dips, short interruptions	:	IEC61000-4-11
10)	Oscillatory Waves	:	IEC61000-4-12
11)	Harmonics and inter harmonics	:	IEC61000-4-13
12)	Voltage fluctuation	:	IEC61000-4-14
13)	Conducted disturbance	:	IEC61000-4-16
14)	Ripple DC Power Supply	:	IEC61000-4-17
15)	Variation of power frequency	:	IEC61000-4-28

Specific Standard of Emission :

16)	Radiated emission	:	EN 50081-1
17)	Conducted emission	:	EN 50081-1
18)	Any other standards as applicable.		

3.6.3 The Contractor shall provide detailed calculations and inter-modulation analysis to establish electromagnetic compatibility (EMC) among the sub-systems and with other systems in close proximity.

3.6.4 All tests shall be conducted to meet EMC severity levels specified by the relevant international standards. As a minimum, the EMC severity levels for industrial equipment shall apply.

3.6.5 The cost incurred in the suppression of electromagnetic or electrostatic interference including any hardware shall be deemed to be included within the contract

3.6.6 The contractor shall ensure that all Intra system EMI are taken care of through proper design and other measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipments operating in Railway environments.

3.6.7 Inter-system EMC

(1) The contractor shall ensure that all equipments are designed and constructed in accordance with latest versions of EMC standards including but not limited to EN 50082, EN 50121, EN 50123, EN 50155, IEC60571, IEC61000 or equivalents to ensure proper functioning

(2) Adequate safety margins between the immunity levels of the Telecommunication_Systems and the emission levels of other electrical and electronic equipment must be maintained.

(3) The design of the software shall take into consideration that with the interference injected into the system, it is possible to produce an abnormal condition. For example the program may become "locked up" awaiting a signal which will never arrive (system hang). It is important therefore that the various possible failures are analysed and appropriate actions are taken when failures are detected.

(4) The probabilities of various conditions which could lead to an unreliable operation must be determined wherever applicable.

3.6.8 Relevant EMC test certificates for all standard off-the-shelf products shall be submitted to the Engineer for review.

3.6.9 Environmental EMC

(1) The contractor shall ensure that the Telecommunication system is immune to the radiated interference from the various transmitters which are likely to be installed near the sensors, cables and other equipment.

(2) IEC61000-5-6 (Electromagnetic Compatibility, Mitigation of external influences) shall be observed wherever applicable.

∗ End of Chapter 3 ∗

4 DESIGN REQUIREMENTS

4.1 General

4.1.1 Design Approach

4.1.1.1 The Contractor shall adopt a structured, modular and top-down approach for the Design and exercise proper design control to ensure that the designs are in accordance with the requirements given in the Specifications.

4.1.1.2 The technologies adopted for the design of the System shall be :

(1) field proven with past successful applications references;

(2) conforming to open international standards.

4.1.1.3 The System shall be designed for continuous unattended operation for extended periods of time.

4.1.1.4 System design shall comply with the requirements of Standard Schedule of Dimensions for Western Corridor of Indian Railways Dedicated Freight Corridor.

4.1.1.5 The Contractor shall submit a Design Plan as stipulated in the GS. The design shall be as a minimum in two stages of Preliminary and Detailed Design.

4.1.2 Design Verification and Validation

4.1.2.1 The Contractor shall submit detailed Design calculations and supporting drawings, documents, etc., for the applicable Subsystems to the Engineer for review.

4.1.2.2 The Design calculations shall demonstrate that the Contractor's Design fully complies with the requirements given in the Specifications and shall further demonstrate that the ratings, capacity and quantity of the proposed equipment are adequate.

4.1.2.3 The Contractor shall furnish the following calculations and analysis for each Subsystem as a minimum:

(1) estimation of the power consumption and heat dissipation per equipment location;

(2) prediction of the reliability and availability of each Subsystem.

4.1.2.4 The requirements on Design calculations specific to the Subsystems shall be as given in Chapters 5 to 11 of this Particular Specification.

4.1.3 Design Review

4.1.3.1 The Contractor shall ensure that all Design submissions are accurate, fully compliant, relevant and of good quality before they are submitted to the Engineer for review.

4.1.3.2 The Contractor shall ensure that all comments of the Engineer have been properly incorporated or otherwise resolved before resubmission.

4.1.3.3 The Contractor shall exercise adequate control to ensure that the number of resubmissions is a minimum.

4.1.3.4 The following issues shall be addressed during each of the Design review meetings:

(1) design Progress;

(2) interface Issues.

4.1.4 MMI Design

4.1.4.1 For all MMIs specially designed or customised for the System, the Contractor shall provide and organise prototypes for demonstration and submission to the Engineer for review prior to implementation.

4.1.4.2 The Contractor shall co-ordinate with the Project Contractors to ensure that the latter's recommendations are properly reviewed, commented upon and the agreed items incorporated in the Contractor's MMI design.

4.1.5 Submission of Samples

4.1.5.1 The Contractor shall submit samples to the Engineer for review, when so required and instructed by latter.

4.1.5.2 The Contractor shall arrange site visits and/or videos for illustration if the items are bulky or impracticable for submission.

4.1.5.3 The Contractor shall provide samples of individual types of cables to the Engineer prior to the commencement of cable installation. The samples shall be properly protected with transparent housing for independent cable components including sheath, armour, insulation, cable cores, etc. for ease of identification as well as inspection. Each sample shall be properly labelled with description of the cable type.

4.1.5.4 All samples submitted to the Engineer shall become the property of the Employer.

4.2 Equipment Design

4.2.1 General Considerations

4.2.1.1 Specific equipment design requirements for individual Subsystems are given in Chapters 5 to 11 of this PS.

4.2.1.2 All active equipment shall have LED indications indicating :

(1) normal operating conditions;
(2) normal power supply;
(3) alarm conditions.

4.2.1.3 All equipment shall be designed and constructed to operate without degradation in quality, performance or loss of function in the electromagnetic environment prevalent in a standard heavy freight corridor Railway System.

4.2.2 Fire and Smoke Precautions

4.2.2.1 The cable routes shall be suitably designed to prevent trapping of rubbish which could later become a fire hazard.

4.2.2.2 Every possible precaution must be taken to prevent the flow of fault currents through the cables, especially from the traction power system. Communication cables must be kept away from high tension power supply cables.

4.2.2.3 All necessary measures shall be adopted to prevent the creation of hazardous conditions arising out of overheating and/or ignition of cables. All cables used must therefore, meet the following stipulations, unless otherwise specified :

(1) The cables meant for installation in OCC shall be made from fire-retardant, low-smoke, halogen-free materials only.
(2) The cables meant for all other areas shall be made from materials as laid down in Indian Railways RDSO latest relevant specifications.

4.2.2.4 Fire-retardant, low-smoke, halogen-free/low-halogen materials shall conform to the under-mentioned specifications:

(1) Flame-retardancy : IEC-60332 Part 1& 3, IEEE-383 & BS 4066
(2) Smoke Generation Test : ASTM D – 662 & BS 6724: Clause 17.4

(3) Limiting Oxygen Index 35 : ASTM D–2863 & BS 2782:Part 1: Method 141
(4) Temperature Index 280oC: ASTM D–2863 & BS 2782:Part 1: Method 143
(5) All insulating material shall be resistant to heat and moisture, with temperature ratings appropriate to the application conditions and in no case below 70oC.
(6) When a sample of the cable is subjected to combustion test for determination of the amount of halogen acid gases as set out in BS6425 / IEC 60754 Part 1, and the amount of halogen acid evolved is less than 0.5%, the cable shall be regarded as halogen-free.
(7) Fire-retardant, low-smoke, low-halogen materials shall meet the requirements of items (1) to (6) above, except that when subjected to BS6425 / IEC 60754 Part 1 test, may evolve halogen acid up to a maximum of 8%.

4.2.2.5 All of the above requirements shall be fully complied with, without compromising any of the mechanical or electrical properties of the cables.

4.3 Environmental Conditions

4.3.1 All equipment shall be protected from damage or degradation in performance due to shock or vibration as experienced in railway environment.

4.3.2 Unless otherwise specified, all telecommunication equipment installed under this Contract shall be designed for operation in temperatures of -5°C to +55°C.

4.3.3 The Telecommunication Equipment Rooms (TERs) shall be provided with air-conditioning. The air-conditioning in stations and OCC shall be provided by the other Contractors.

4.3.4 The Telecommunication Equipment Rooms (TERs) at porta Huts shall be provided with Panel air-conditioning. The air-conditioning shall be provided by the ST P-5 Contractor.

∗ End of Chapter 4 ∗

5 OPTICAL FIBER CABLE COMMUNICATION SYSTEM REQUIREMENTS

5.1 General

5.1.1 The OFC Communication System shall be the communications backbone between the OCC, stations, other locations and the ELMD.

5.1.2 The OFC shall be a highly reliable system since it shall be the primary means of remote communications between OCC, stations, ELMD, GSM® Base station locations, TSSs, SPs, SSPs, ATSs, etc, on which a number of other operationally critical systems rely.

5.1.3 The OFC shall provide a high degree of availability and redundancy by operating on two independent optical fiber rings. Proven technology of SDH (Synchronous Digital Hierarchy) as per ITU-T Rec. G803 shall be adopted.

5.1.4 The OFC shall be capable to transport all of the user communication interfaces and therefore the bandwidth provided by the OFC shall be matched to the loading required by the data speed of the subsystem interfaces. The OFC shall provide sufficient bandwidth to cater for the data loading required at the present implementation stage and shall provide an additional spare bandwidth of at least 50% of the usable total bandwidth in respect of SDH Network and flexible access multiplexer network for future system expansion.

5.1.5 Data Networking System (WAN) shall be provided between OCC, stations and ELMD. It shall be the primary means of Packet Data Communications between OCC, Stations and ELMD.

5.1.6 WAN shall be highly reliable, robust, scalable, secure, efficiently manageable and based on proven equipment and topology.

5.1.7 WAN shall provide sufficient bandwidth for sub systems of Master Clock, Traction Power SCADA, BMS, Vital & Safety related Signal Control Circuits etc. WAN shall have as a minimum 50% spare bandwidth for future requirements.

5.2 Scope of Supply for OFC

5.2.1 The scope of supply shall include, but not be limited to the following:

(1) SDH transmission equipment;
(2) STM Multiplexers;
(3) Flexible Access Multiplex equipment;
(4) Wide Area Networking equipment consisting of redundant Layer-3 switches at OCC, every station and as required at other locations;
(5) NMS(s) for OFC communication system , Access Multiplexer system and Wide Area Networking system;
(6) all software and licenses;
(7) Single Mode Optical Fiber Cables;
(8) splice boxes and remake loops;
(9) distribution frames;
(10) terminating and interconnecting equipment including termination protection devices;
(11) equipment cabinets, racks and cubicles;
(12) all required connectors;
(13) installation materials;
(14) power supply and all other data cables, earthing and accessories including termination protection devices; and
(15) any other materials to complete the scope of work.

5.2.2 SDH node equipment at ELMD is not in the scope of ST P-5 as this will be provided by the RS P-7 contractor. OFC cables for the First (main) OFC network including for ELMD shall be provided by the ST P-5 contractor.

5.3 System Requirements

5.3.1 The OFC communication system shall be a Synchronous Digital Hierarchy (SDH), based on an open standard and fully conforming to the ITU-T Recommendations.

5.3.2 The OFC system shall support voice, data and video signal transmission between various locations and modes of transmission shall include, but not limited to:

(1) point-to-point;
(2) point-to-multipoint;
(3) drop-and-insert;
(4) cross-connect; and
(5) any other modes required for the implementation of the Subsystems.

5.3.3 Optical Fiber Cable Backbone Network

5.3.3.1 There shall be two separate optical fiber cable back bone networks as detailed below:

5.3.3.1.1 Each of the optical fiber cable networks shall be formed by two outdoor single mode optical fiber cables, one laid along the up-track and the other along the down-track. The normal and protected routes shall be routed through different fiber cables with path diversity.

5.3.3.1.2 Optical fiber cables of the first network shall be terminated in ODFs in Central Equipment Room (CER) at OCC, TERs at stations and TER at the Electric Locomotive depot and any other locations as required. In addition OFC cables of the First network shall also be terminated at one of the SDH/GSM-R nodes in porta huts approximately midway between adjacent stations.

5.3.3.1.3 Optical fiber cables of the second network shall be terminated in ODFs in CER in OCC, TERs at stations and in porta huts between stations housing SDH & GSM-R equipment.

5.3.3.1.4 For requirements of OFC fibers between TERs as above and other locations such as level crossing gates and TSSs, SSPs, SPs & ATSs for dispatcher telephones and data for SCADA, etc the OFC cables of secondary network may be tapped and terminated at distances not less than 2 km and for distances less than 2 km separate 12/6 core main and redundant OFC cables as spur links shall be laid from the nearest TER at station or the porta hut.

5.3.3.1.5 The First network (Main OFC) shall have a minimum fiber count of 24 fibers for each of the two cables. The Second network (Secondary OFC) shall have a minimum fiber count of 12 fibers for each of the two cables. At least 50% of fibers within each cable shall be reserved as spares for future use.

5.3.3.1.6 Each of the main, secondary OFC cables and spur link OFC cables shall be laid in separate HDPE ducts. The Contractor shall determine the exact total number of fibers for the outdoor single mode optical fiber cable for the First, Second and the spur link networks between various locations.

5.3.3.1.7 The phase - I OFC system network has to later get connected with the WDFC OFC system network of phase 2 towards Dadri and JNPT and work as a single OFC Communication system. Requirements of fibers, over the phase-I route of WDFC, for

this integration of phase 2 requirements shall be provided in the cables of First network (Main OFC).

5.3.3.1.8 The optical fiber cables within the station/ELMD/OCC shall be laid along different routes to provide 100% route diversity.

5.3.3.1.9 First network shall carry, but not limited to, all voice and data communication between OCC, stations, ELMD, other locations (as determined during design) and cross connected traffic from the second network.

5.3.3.1.10 The second network shall carry, but not limited to, all voice (including dispatcher telephone and EPABX telephone communication) and data (including requirements of traction power SCADA) communication between stations, Auto section locations, porta huts, LC gates, TSSs, SPs, SSPs & ATSs etc.

5.3.3.1.11 Optical fiber cables terminated at the optical distribution frame (ODF) shall be either spliced through or spliced with optical pigtails or terminated at the optical patch panels including the spare fibers. ODFs shall be provided in the TERs at all the locations.

5.3.3.1.12 At least 5 metres slack in each optical fiber cable at all equipment rooms/locations shall be reserved for future network modification and expansion. The slack cable shall be suitably managed.

5.3.4 SDH Network

5.3.4.1 The SDH nodes shall consist of STM multiplexers with optical line terminals connected to optical fiber cable backbone network to form the SDH network of the OFC system. The SDH network shall provide dual and self-healing protected transmission paths.

5.3.4.2 SDH node, at each station and ELMD as a minimum shall be of STM-4 level or higher expandable to STM-16 level and STM1 ADM in the SDH hierarchy. SDH node at OCC as a minimum shall be of STM-4 or higher level expandable to STM-16 level or higher. The exact level of each node shall be determined by the Contractor to meet the total bandwidth required for the Subsystems implementation, bandwidth required by relevant Project Contractors and band width required for integration of OFC Communication system of phase II with phase I system and 50% equipped spare capacity for expansion.

5.3.4.3 The SDH equipment at stations and ELMD shall be fully equipped minimum for 63 E1s with 1:3(minimum) protection for 2MB tributaries and 1+1 protection level for all other tributaries including STM-1 and voice and data channels.

5.3.4.4 SDH equipment at each Telecom Equipment Hut for GSM-R radio base stations shall be of STM-1 ADM level or higher, expandable to STM4 and equipped minimum for 21 E1s with 1+1 protection for all tributaries including 2MB and voice and data channels.

5.3.4.5 For SDH equipment at OCC the contractor shall determine the requirement of E1s and provide a minimum 50% additional equipped spares capacity and a minimum of 1:3 protection level for all 2 MB tributaries and 1+1 protection level for all other tributaries including STM-1 and voice and data channels.

5.3.4.6 The SDH nodes at OCC and stations shall be of cross-connect type. SDH nodes at other locations shall be either Add-Drop or cross connect as required. Signal transmission in the SDH network shall be protected with path diversity.

5.3.4.7 SDH equipment shall be equipped with Ethernet over SDH (EoS) as per ITU-T Rec. G 7041at 10/100 Base T. This Ethernet over SDH (EoS) shall facilitate delivery of Ethernet Private Line (EPL) Services, Ethernet Virtual Private Line (EVPL) Services and Ethernet Local Area Network (E-LAN) Services. The EoS shall support Layer 2 encapsulation and forwarding through Multiprotocol Label Switching (MPLS) using Ethernet Pseudo Wire (PWE3).

5.3.4.8 In order to realize the above mentioned services, there shall be in-built layer-2 Bridging and & Aggregation functionality as per IEEE 802. 1d. There shall be support for VLAN Stacking (Q-in-Q) as per IEEE 802.1ad on all ports. The equipment shall support Ethernet Link OAM in accordance with IEEE 802.3ah. The equipment shall also support Link Aggregation & Protection on service and trunk ports as per IEEE 802.3ad.

5.3.4.9 All common cards/units e.g. Control/Processor Card (if its failure affects traffic), Switch/Matrix Unit, Timing Card and Power Supply Modules etc of SDH equipment shall be provided with (1+1) hot standby configuration.

5.3.5 Access Network

5.3.5.1 Each SDH node shall provide direct access of tributary signals including, but not be limited to:

(1) STM optical and electrical signals of same /lower levels;
(2) 2Mbps or the E1 tributaries;
(3) Ethernet tributaries at 10/100 Base T;
(4) any other tributaries of data rate between E1 and STM 1 as required.

5.3.5.2 The SDH nodes at stations and OCC shall be equipped with a minimum of 4 Ethernet 10/100 Base T EoS tributaries. SDH nodes in all porta huts shall be equipped with Ethernet 10/100 Base T EoS tributaries as required.

5.3.5.3 Flexible access multiplexers or primary order multiplexer shall be provided to connect to the 2Mbps tributaries of the SDH nodes for direct access of channel circuits with data rate lower than 2Mbps.

5.3.5.4 Channel circuits below 2Mbps level shall be divided among the multiplexers for maximum diversity. All the channel circuits, including spare circuits, shall be terminated at the main distribution frame, digital distribution frame as appropriate for circuit access.

5.3.5.5 The OFC shall provide voice and data communication circuits or bandwidth for the following systems but not limited to:

(1) 2 Mbps E1 (ITU-T G.703 and G.823) channels for the Telephone System;
(2) Data circuits for the Radio System such as Primary Rate E1 interface;
(3) Ethernet 10/100 ports or other data circuits as required for SCADA, BMS, Dispatcher Telephone System, Clock System etc. Other data circuits or Ethernet 10/100 ports or dark fiber for requirements of Signalling Systems; and
(4) the OFC shall provide a bandwidth management tool to ensure sufficient transmission capacity for each application to function under all traffic circumstances on the OFC system;

5.3.6 Wide Area Networking (WAN) system

5.3.6.1 WAN shall connect OCC, stations and ELMD etc in ring Topology using Optic Fiber cable.

5.3.6.2 WAN shall be implemented using Layer-3 Access Switches. Layer-3 Switches shall as a minimum be equipped with 4 Nos. of 10 GigE Fiber ports and a minimum of 24 Nos. of 10/100/1000 Base T ports with RJ45 connectors.

5.3.6.3 Ethernet Services such as EPL Services, EVPL Services, E-LAN Services, L2PT, VPWS & EoMPLS shall be available on WAN. Ethernet Services such as EPL, EVPL & E-LAN shall be extended to the locations like Auto section locations, LC Gates, TSSs, SPs, SSPs, ATSs etc. using EoS of OFC system or if required by suitable Layer 2 switch networks for meeting the requirements of systems within this contract and outside this contract as decided by the Engineer. Details shall be submitted to the Engineer for review.

5.3.6.4 Layer-3 Services such as IPv4 Routing [Border Gateway Protocol (BGP), Intermediate System to Intermediate System (IS-IS), Open Shortest Path First (OPSF), Virtual Router Redundancy Protocol (VRRP)], IPv6 Routing, Multi Protocol Label Switching [Label Distribution Protocol (LDP), Targeted LDP (T-LDP), Primary & Secondary label Switched Paths, MPLS L3 VPN, Resource Reservation Protocol (RSVP), MPLS Traffic Engineering (including TE-FRR), Routed Pseudowire], IP-VPN (RFC 2547) and Integrated Routing & Bridging shall be available on the WAN to cater to the communication requirements of various sub systems and other project contractors including future expansion requirements.

5.3.6.5 Quality of Service (QoS) feature such as Ingress & Egress Marking, Ingress & Egress Policing, Priority Queuing, Class-Based Queuing, WRED, Scheduling and Access Control List shall be available on the WAN.

5.3.6.6 Multicast Protocol such as Internet Group Management Protocol (IGMP) and Protocol Independent Multicast (PIM) shall be available on the WAN.

5.3.6.7 WAN shall support IPv4 & IPv6 Protocols. It shall support Static as well as Dynamic Host Configuration Protocol (DHCP) based IP address Management.

5.3.6.8 Security Features such as Authentication, Authorisation & Accounting (AAA), Secure Shell Protocol (SSH), MAC Limiting per Ethernet Flow-point, Unicast/Multicast/Broadcast storm control Blocking, Layer-2 ACL, Layer-3 ACLs for IPv4 & IPv6 and DHCP Snooping shall be available on the WAN.

5.3.6.9 OAM feature such as CFM OAM(IEEE802.1ag), EFM OAM(IEEE802.3ah), MPLS OAM and OAM functions and features as per ITU-T Y.1731 shall be available on the WAN.

5.3.6.10 NMS for the complete Data Network shall be GUI based and provide necessary control, supervision, maintenance, configuration and performance management functions. NMS shall support Layer-2 & Layer-3 services as detailed above. The NMS shall as a minimum support the following features:

1) Fault Management and Analysis
2) GUI and Service Template based Configuration and Provisioning
3) Composite L2/L3 Service Creation and Management
4) Performance Statistics collection & Management
5) Security Management
6) OAM Testing
7) Troubleshooting and Assurance

8) Historical and real time path monitoring
9) Path computation for Network Planning/Traffic Engineering tools integration

5.3.6.11 In each station, OCC and the ELMD, a Local Area Network (LAN) to Fast Ethernet standard shall be built for local data applications.

5.3.7 OFC system network synchronisation

5.3.7.1 The OFC system synchronisation shall adopt master and slave synchronisation method.

5.3.7.2 The SDH equipment shall derive the synchronisation timing signal from, but not limited to the following in order of priority :
(1) master clock equipment;
(2) an internal clock of the SDH equipment;
(3) incoming STM signal; and
(4) incoming 2 Mbps signal.

5.3.7.3 The SDH equipment shall switch automatically to another timing reference if the selected timing reference is lost under the criteria stipulated in ITU-T G.783.

5.3.7.4 The SDH equipment shall provide user-selection of synchronizing the outgoing STM signal in one of but not be limited to the following synchronization modes:
(1) internal Clock Mode; and
(2) incoming STM to outgoing STM signals.

5.3.7.5 When all the incoming timing references are lost, the equipment shall be capable of entering into holdover mode.

5.3.7.6 The Network Element equipment shall support programmable prioritized synchronization source selection scheme covering all available synchronization sources.

5.3.7.7 When failures of synchronization at a source occur, the equipment shall be able to select automatically a lower priority source to prevent loss of synchronization.

5.3.7.8 The priority list and the synchronization source currently used by the equipment shall be retrievable.

5.3.7.9 The Network Element equipment shall be able to monitor all failed and normal synchronization source(s) and select the one available with the highest priority.

5.3.7.10 Synchronization network shall be protected against single Transmission Network node/link failure, that is, a single node/link failure shall not cause a complete loss of synchronization reference to any Transmission Network nodes.

5.3.7.11 Engineering of the synchronization network plan shall ensure the normal functional operation and no voice performance degradation of the inter-telephone switch communication and GSM-R radio voice communication.

5.3.7.12 Automatic re-configuration of synchronization source shall not cause any interruption or generation of errors in any low speed and high speed signals being transported by the Network Element equipment.

5.3.7.13 Synchronization plan shall prevent repeated switchovers of synchronization sources automatically when intermittent/frequent failures occur in the clock source(s).

5.3.7.14 The Network Element equipment shall provide manual switchover to a specific synchronization source irrespective of its priority in synchronization sources selection with password protection. Manual switchover to a failed synchronization source shall be prevented by the equipment.

5.3.7.15 Facilities shall be provided at the Network Element equipment to monitor the performance of the derived synchronization timing signals and report the corresponding alarm conditions to the NMS.

5.3.8 Network Protection

5.3.8.1 The SDH equipments shall support protection mechanism such as Linear Multiplex Section Protection, Sub Network Connection Protection (SNCP), Multiplex Section Shared Protection Ring (MSSP Ring).

5.3.8.2 Path Protection implementation through SNCP is preferred. SNC Protection shall be provided at VC-4, VC-3 and VC-12 level. Signal transmission shall be protected on per path basis.

5.3.8.3 Automatic path protection switching shall occur upon detection of failure or alarm conditions which will affect the quality of signal transmission. The protection switching shall be completed within 50ms. Manual protection switching shall be initiated by a switch command from the NMS.

5.3.8.4 Failure of any single SDH node shall not affect the operation of the remaining SDH nodes in the network. Fault in any single fiber cable section shall not affect the operation of any SDH node or sub-systems data exchange. Alarm of the particular node shall be raised at the NMS.

5.3.8.5 The normal and protected routes shall be routed through different fiber cables with path diversity.

5.3.8.6 The Flexible Access Multiplex Equipment shall be provided with 1+1 Redundancy for all Channel levels (Voice, Data, etc.). Further 1+1 Protection for Control & Power Supply Modules/Cards shall be provided.

5.3.8.7 No single failure shall affect the availability of OFC system or the interfaces.

5.3.8.8 The OFC system, under the fault conditions, shall remain in operation and automatically reconfigure, if necessary, without the need for control by the NMS.

5.3.9 Service Telephone / Order Wire

5.3.9.1 A service telephone/ engineers order wire with handset shall be provided at each SDH node location for point to point and multipoint voice communication calls between maintenance staff at different node locations. It shall permit selective and group call functions.

5.3.9.2 The operation of service order wire /service telephone system shall not affect the operation of the signal transmission within the OFC system.

5.3.10 Network Management System

5.3.10.1 System Configuration

5.3.10.1.1 At the OCC (or at any other location decided by the Engineer), a Network Management System (NMS) shall be provided to carry out real-time centralised and remote monitoring and measurement of network status and performance, and the ability to take prompt action to control the flow of traffic when necessary.

5.3.10.1.2 The equipment to be managed shall include SDH equipment, flexible access multiplexer or primary order multiplexers, optical line terminals and WAN & LAN system equipments etc.

5.3.10.1.3 NMS Workstation shall be installed at the OCC telecommunication equipment room (Central Equipment Room) for the operation of the NMS.

5.3.10.1.4 The NMS shall be equipped with spare ports for future additional Workstations and the ports shall allow remote connection through commercially available modems.

5.3.10.1.5 NMS workstation shall be equipped with a log printer for alarm and event print-out.

5.3.10.1.6 The NMS shall be equipped with mass storage device for storage of the configuration and alarm data-files.

5.3.10.1.7 The mass storage device shall provide facilities for downloading the configuration and alarm data files to CD/DVD/pen drive.

5.3.10.1.8 Laptop Portable service terminals loaded with NMS Software shall be provided for maintenance access to the network elements at various node locations.

5.3.10.1.9 The NMS shall have an internal clock synchronised to the master clock for the time and date information. The internal clock shall allow free running in case of loss of signal from master clock.

5.3.10.1.10 ST P-5 and RS P-7 contractors will interface to integrate the SDH and other equipment of ELMD with WDFC NMS and detail the management functions as applicable to the equipment at ELMD.

5.3.10.2 Operations, Administration, Maintenance & Provisioning (OAM&P) Functions

5.3.10.2.1 The NMS shall provide OAM&P functions in accordance with the Telecommunications Management Network (TMN) concept described in ITU-T Recommendations M-3010.

5.3.10.2.2 Protection and alternative routes shall be provided for the network management traffic in case of faults in the OFC system.

5.3.10.3 Alarm and Status Monitoring

5.3.10.3.1 The operational status and performance of all the network elements shall be monitored on a real time basis by the NMS. The status monitoring shall be down to the card level as a minimum.

5.3.10.3.2 The network elements shall have alarm logging facilities so that a detailed history of the failure alarms can be retrieved either locally using the portable service terminal or remotely by the NMS.

5.3.10.3.3 Alarms to be collected from network elements shall include, but not be limited to the following:

(1) input failure;

(2) loss of frame alignment;
(3) high error rate alarm;
(4) loss of pointer;
(5) loss of synchronisation;
(6) out of frame alignment;
(7) alarm indication;
(8) high/low optical power;
(9) high laser bias;
(10) tributary unit failure;
(11) power unit failure;
(12) external synchronisation failure;
(13) mains power failure; and
(14) any card/ module failure.

5.3.10.3.4 Failure alarms shall be classified into user configurable major/ minor etc. alarms. All alarms and status changes shall be stored in local storage of network elements, stored in mass storage device at OCC and output to the printer on demand. All alarms and status shall be stamped with time and date within an accuracy of 1 second.

5.3.10.3.5 Each alarm log shall include details on the type and nature of the fault, alarm category, fault location, date and time fault is detected and date and time the fault is cleared. An audible alarm shall be given at NMS workstation and shall be reset by maintenance staff on acknowledgement.

5.3.10.3.6 A local alarm indication for the network element shall be given and shall be reset automatically upon the alarm is cleared.

5.3.10.3.7 A summary alarm shall be provided at the rack top to indicate the alarm status of any element within the rack. The summary alarm shall be reset automatically upon the alarm is cleared.

5.3.10.3.8 The NMS shall provide function for user to enable and disable output of alarm events to the log printer.

5.3.10.4 Performance Monitoring

5.3.10.4.1 The NMS shall calculate, display and provide print-out of the performance statistics for the OFC system.

5.3.10.4.2 In-service performance monitoring for all network elements shall include, but not be limited to the following performance parameters:

(1) laser bias current;
(2) optical power transmitted;
(3) optical power received;
(4) degraded duration in minutes;
(5) severely error seconds;
(6) protection switching counts;
(7) protection switching duration;
(8) error seconds of the received E1 and above signals; signal level of the received E1 and above signals;
(9) error free seconds of the received E1 and above signals; and
(10) bit error rate of the received E1 and above signals.

5.3.10.4.3 Loss of power shall not cause any corruption or loss of data in the network elements and the NMS.

5.3.10.4.4 The in-service performance data files shall be able to be transferred to disk or any other storage media subject to review by the Engineer. The data files shall be in format to allow analysis using commercially available software.

5.3.10.5 Network Configuration and Provisioning

5.3.10.5.1 The Contractor shall provide a main and standby database for storing the system hardware and software configurations. Both the working and backup configuration data base shall be automatically and simultaneously updated for any changes in the data base.

5.3.10.5.2 The NMS shall allow the user to configure all existing and new circuits with the following functions:

(1) frame position allocation;
(2) interface port allocation;
(3) low speed (64 kbit/s & lower) interface cards configuration;
(4) lower order multiplex time slot allocation and routing;
(5) higher order multiplex/cross-connect switch configuration;
(6) logging of circuit routing data logged into configuration database; and
(7) operator's configuration check function prior to main and backup database update.

5.3.10.6 User Interfaces

5.3.10.6.1 NMS functions shall be performed via a user-friendly graphical user interface (GUI) in real-time mode.

5.4 Performance Specification

5.4.1 General

5.4.1.1 In addition to what has been specified in Chapter 3 the following performance requirements for the OFC system shall be complied:

5.4.1.2 Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

5.4.2 Reliability

5.4.2.1 The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

5.4.2.2 The Contractor shall furnish for the following sub-systems/equipment, the reliability figures, MTBF Hours from the OEMs:

(1) SDH Node Equipment
(2) Access Multiplex
(3) Network management system
(4) WAN & LAN equipment

5.4.3 Availability Requirements

5.4.3.1 The contractor shall implement a RAMS Plan for OFC system and WAN/LAN systems defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the OFC system shall not be included in the

determination of the system availability. Contractor shall submit to the Engineer for review and consent the RAMS analysis for the OFC system and WAN/LAN system to establish the requirements of availability specified here below.

5.4.3.2 The availability of OFC system at circuit level shall be defined as the availability of the circuit between both end points of the Optical Fiber Communication System Network where the required bandwidth is available for access. The equipment connected for the access for the circuit bandwidth shall be excluded from the availability calculation.

5.4.3.3 Any circuit of the OFC system shall be considered unavailable if;

(1) there is a loss of communication between end points of the circuit; or
(2) quality of the signal transmission within the circuit is below the performance standards stipulated in this Particular Specification.

5.4.3.4 The availability of any circuit at 2 Mbps level or higher within OFC system shall be better than 99.999%.

5.4.3.5 The availability of any circuits below 2 Mbps level shall be better than 99.999%.

5.4.3.6 The Network Management System (OFC system & Data network) shall be considered unavailable if any functions provided by the Network Management System cannot be properly exercised. The availability of the Network Management System shall be better than 99.5%.

5.4.3.7 The availability of Data Networking System shall be defined as the availability of the bandwidth between both end points of the data networking system. The equipment connected for the access of bandwidth shall be excluded from the calculations. The availability of Data Networking System shall be better than 99.999%.

5.4.3.8 To improve the availability of the data networking system various measures such as Resilient Ethernet Protocol, Pseudo wire Redundancy, Ling Aggregation (IEEE 802.3ad) on Network/ Access Ports, Rapid Spanning Tree Protocol (IEEE 802.1w), Multiple Spanning Tree Protocol (IEEE 802.1s), MPLS-TE Fast Reroute etc. as required shall be implemented..

5.4.4 Maintainability Requirements

5.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

5.4.4.2 The service life of the OFC system (equipment) and Data Networking System (equipment) shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years.

5.4.5 System Safety Requirements

5.4.5.1 In the event of a break in the optical fiber cable, the optical transmitter laser output shall shut down to a safe level as defined by IEC-60825, ITUT-G 958. The shutdown mechanism shall not be software dependent.

5.4.5.2 All equipment must comply with, and be installed in conformance with IEC 60065 and IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

5.4.5.3 Switch equipment shall conform to IEC 60950 Standard for safety requirements of IT equipment.

5.4.5.4 All metallic enclosures shall be provided with an earth terminal and connected to earth.

5.5 Technical Requirements

5.5.1 General

5.5.1.1 The Contractor shall submit the following information to the Engineer for review:

(1) details on the specifications of each low speed data and voice channel interfaces below E1 level;

(2) details on all the available data and voice channel interfaces that the flexible/primary order access multiplexer can be equipped with and, the limitations;

(3) details on the hardware modularity of each type of data and voice interface including the incremental number of interfaces that can be added to a partially equipped equipment shelf and limitations on the addition of the interfaces to the equipment already equipped with mixed types of interfaces shall be defined;

(4) details on the electrical and physical specifications of the local maintenance port which support remote and local operation, administration, maintenance and provisioning (OAM&P) functions of the equipment;

(5) the calculations of delay for signal transmission between SDH nodes;

(6) optical link budget calculations for all the transmission links;

(7) a list of alarms for which the faults shall be detected;

(8) format in which alarms shall be displayed and remotely accessed for printing and display;

(9) the details on the maximum number of tributary signal interfaces that can be supported by the SDH node and the limitations;

(10) the details of the synchronisation network design and a synchronisation plan which describes the fall back arrangement, failure and restore criteria used to determine the switchover of synchronisation sources, the associated timings under each failure and restoration event and the method used in preventing repeated switchovers of synchronisation sources automatically when intermittent/frequent failure occur in the clock sources;

(11) the details of the NMS design, flow of management traffic and protection against SDH node failures or cable failures;

(12) types and maximum number of transmission equipment supported by the NMS;

(13) self-healing mechanism, normal traffic flow diagrams, protected traffic flow details for various single and multiple cable(s) and/or node(s) failures;

(14) architecture of the SDH rings both for main and secondary networks.

(15) normal and protected bandwidth allocation, maximum traffic capacity and method of calculation for the SDH Network.

(16) Details of Fiber allocation for each OFC cable between various locations, proposed use, spares and termination detail at each location; and

(17) Similar details shall also be submitted in respect of Data Network system.

5.5.1.2 Contractor shall estimate and provide the bandwidth needed in order to guarantee the level of service requested by all the subsystems.

5.5.2 Technical System Performance

5.5.2.1 The OFC equipment shall operate satisfactorily at –48V +/- 20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the maximum voltage.

5.5.2.2 The OFC shall conform to relevant ITU-T G-series Recommendation.

5.5.2.3 The jitter and wander performance shall conform to ITU-T Rec. G.783, G.823, G.825 and G 958 as applicable.

5.5.2.4 Voice circuits shall have an end to end performance in accordance with ITU-T Rec. G.712 .

5.5.2.5 Data circuits shall have an end to end error performance in accordance with the ITU-T Rec. G-821.

5.5.2.6 The maximum traffic interruption time for any required service bit rates due to link, node or any other failure shall be less than 50 ms. It shall include the duration for protection switch time completion with the sequence of events below.

(1) from the onset of a failure detection to the completion of protection switching;
(2) from the clearing of a failure to the completion of protection switching recovery (in case of reversion switching);
(3) from the activation of the recovery command to the completion of protection switching recovery (in case of non-reversion switching; and
(4) re-framing time required by equipment including, but not be limited to, SDH equipment, flexible multiplexers, optical line terminal and data modem.

5.5.2.7 The absolute group delay, at the frequency of minimum group delay, shall not exceed the limit of 600 microseconds, per ITU-T Recommendation, taking into account of the worst delay scenarios.

5.5.2.8 The system response times of the NMS shall be as follows:

(1) commands presented to the NMS from Management Workstation shall be processed and produce an appropriate output within 2 seconds maximum;
(2) real-time data presented to the Management Workstation from the network elements shall be processed and produce the appropriate output within 2 seconds maximum; and
(3) execution of parameter changes to SDH Nodes initiated through the NMS shall be less than 2 seconds.

5.5.3 Equipment Design Requirements

5.5.3.1 General

5.5.3.1.1 The equipment design of OFC shall be of standard rack with plug-in units. Hot swapping capability shall be provided for all cards/units including redundant power supplies. Hot-swapping of the plug-in units shall not affect the equipment operation.

5.5.3.1.2 A summary alarm indication shall be provided at the top of each rack to indicate the summary alarm status of the equipment within the rack.

5.5.3.1.3 Equipment shall be equipped with protected test points for measurement and performance monitoring without affecting the traffic. Test access facilities shall be provided at different transmission levels.

5.5.3.1.4 Equipment shall be provided with natural cooling arrangement, however if natural cooling arrangements are not adequate, the use of fan shall be allowed provided.

- The fan failure is reported through LCT/OFC NMS.
- Multiple fans are used in one tray with (n:1) hot standby redundancy.
- Fans are DC operated
- MTBF of fan is better than 80,000 hours.

5.5.3.2 SDH Equipment

5.5.3.2.1 All SDH node equipment shall conform and be compliant with ETSI 300 147and relevant ITU-T Rec. including G.707 to G.709, G.781 to G.784 and G.957 to G.958.

5.5.3.2.2 It shall be possible to configure SDH equipment as Terminal Multiplexer, multiple Terminal Multiplexer, Add Drop Multiplexer, multiple Add Drop Multiplexer

5.5.3.2.3 SDH nodes at stations shall provide Cross Connect capabilities with a granularity of VC4, VC3 and VC12.

5.5.3.2.4 Each SDH node shall be equipped with (1+1) redundant configuration at optical and electrical levels including power supply, minimum STM-16/STM-4/STM-1 level as applicable.

5.5.3.3 Flexible Access Multiplex Equipment and Optical Line Terminals

5.5.3.3.1 Flexible Access Multiplex Equipment shall conform to ITU-T Rec. G.703, G.704, G.706, G.707, G.708, G.709, G.711, G.732, G782 and G.823.

5.5.3.3.2 Flexible Access Multiplex Equipment shall support Primary Multiplexing, Digital Branching and Digital Cross Connect. The granularity of Digital Cross Connect shall be N X 8 Kbits/Second.

5.5.3.3.3 Flexible Access Multiplex Equipment shall support functionalities of Terminal Multiplexer, Protected Terminal Multiplexer, Drop/Insert Multiplexer, Bypass Multiplexer and Loop Protected Multiplexer.

5.5.3.3.4 Flexible Access Multiplex Equipment shall support Omnibus Operation of Voice in digital format and Data Channels.

5.5.3.3.5 Flexible Access Multiplex Equipment shall have in-built feature to provide details of performance data like AS, ES, SES, DM, etc. via NMS or via Laptop Service Terminal.

5.5.3.3.6 Adequate numbers of Primary Multiplexers shall be provided so that there is no loss of Communication at any point of time.

5.5.3.3.7 Flexible access multiplexer equipment shall be provided with 1+1 protection for all channel levels (VF and Data, etc.) with automatic switch over in case of fault.

5.5.3.3.8 The Optical Line Interfaces shall conform to ITU-T Rec. G957 & G958.

5.5.3.4 Channel Interfaces

5.5.3.4.1 Where required, the Digital Transmission equipment shall provide voice frequency interfaces for analogue telephone sets located not at the switch site, including but not be limited to the following, subject to the Approval of the Engineer:

(1) voice interface selectable on two or four wires E&M signalling conforming to ITU-T Rec. G.713 and G.712 respectively;
(2) voice interface microphone current feeding, subscriber loop signalling, on hook/off hook detection, ring trip and ringing current provision;
(3) voice interface providing voice line connection to Extensions (FXS Interface) & EPABX (FXO Interface); and
(4) any other voice interfaces required for other Subsystems/ designated contractors.

5.5.3.4.2 The Contractor shall determine and provide appropriate types and quantities of channel interfaces based on the requirements of the Subsystems.

5.5.3.4.3 The Contractor shall submit the details of all the channel interfaces which can be supported by the flexible access multiplexer or the primary order multiplexer.

5.5.3.4.4 The voice interface shall be Pulse Code Modulated (PCM) in A-law as described in ITU-T Rec. G.711.

5.5.3.4.5 The flexible access multiplexer equipment shall also support/provide data interfaces, including but not be limited to the following, subject to the Approval of Engineer:

(1) 0-19.2kbps synchronous or asynchronous data complying with ITU-T Rec. V.11 (EIA RS-422 or RS-485) interface etc;
(2) 0 up to 100 Kbps selectable asynchronous/synchronous full duplex data transmission complying with EIA/TIA-232-E and V.28 standard;
(3) 64 kbps synchronous data interfaces complying with ITU-T Rec. G.703 unbalance interface;
(4) nx64 kbps synchronous data interfaces complying with ITU-T Rec. V.11 and V.35 interface;
(5) 2.048Mbps synchronous data complying with ITU-T G.703 unbalance interface;
(6) ISDN Basic Rate Interface with 2B+D channels as defined in ITU-T Rec. I.430;
(7) Primary Rate Interface complying with ITU-T Rec. I.431 interface at 2.048 Mbps (30B+D); and
(8) any other data interfaces required for other Subsystems.

5.5.3.5 Layer 3 Switches (WAN Equipment)

5.5.3.5.1 The Layer 3 Access Switches of WAN shall meet the following specifications as a minimum:

5.5.3.5.1.1 Shall have minimum 24 Nos. 10/100/1000 Base-T Auto Sensing Ports complying with IEEE 802.3, IEEE 803.3u and IEEE 802.3ab standard, supporting Half Duplex, Full Duplex and Auto-Negotiation on each port to optimise bandwidth.

5.5.3.5.1.2 Shall have minimum 28 Gbps forwarding bandwidth at Layer2 and Layer3 Switching Fabric.

5.5.3.5.1.3 Shall have a minimum of 32 million packets (64 Byte packets) per second forwarding rate.

5.5.3.5.1.4 Shall have a minimum of 8000 MAC address space.

5.5.3.5.1.5 Shall be capable of working with -40V to -54V DC supply of the Battery backup system or AC 230 V of the Power Supply System (PSS) being provided by the contractor. Power supply module shall be redundant and inbuilt in the switch.

5.5.3.5.1.6 It shall be possible for the Layer 3 switch to be mounted in a 19" rack. All accessories required for mounting shall be supplied.

5.5.3.5.1.7 Shall support features such as Link Aggregation (IEEE 802.3ad), VLAN on all Ports (IEEE 802.1Q), VLAN Tagging (IEEE 802.1q), Minimum 256 VLANs, Port-Based Authentication (IEEE 802.1x), Spanning Tree Protocol (IEEE 802.1d), Rapid Spanning Tree Protocol (IEEE 802.1w), Multiple Spanning Tree Protocol (IEEE 802.1s), Dynamic Host Configuration Protocol (DHCP), Inter VLAN IP Routing for Layer-3 Routing, IPv6 Routing, Strict Priority Queuing, RADIUS Protocol for console access restriction and authentication per RFC 2138, Basic IP Unicast Routing Protocols (Static, RIPv1, RIPv2, OSPF), Classification and Scheduling on all ports (IEEE 802.1p).

5.5.3.5.1.8 Shall support multiple privilege level to provide different level of access on console port and telnet sessions.

5.5.3.5.1.9 Shall support Online Software Reconfiguration to implement changes without rebooting. The OS for the switches must be modular and the same certified by the OEM.

5.5.3.5.1.10 Shall support Telnet, SNMP (Simple Network Management Protocol) V1/V2/V3, Network Time Protocol, SSH (Secure Shell) V1/V2 and FTP (File Transfer Protocol).

5.5.3.5.1.11 Shall have a console port with RS-232 interface for configuration, and diagnostic purposes.

5.5.3.5.1.12 These Switches shall be configured with Redundant Supervisor/Switching Fabric/Management Modules/Power Supplies. All switch components shall be hot-swappable without disrupting the operations.

5.5.3.5.1.13 Network Management System shall communicate with elements of WAN over SNMP (Simple Network Management Protocol) V1/V2/V3.

5.5.3.6 Network Management System

5.5.3.6.1 The NMS shall have provision to monitor network performance in accordance with ITU-T Rec. G.831.

5.5.3.6.2 The NMS shall be equipped with a proven real-time, multi-tasking operating system to support centralised network management of the OFC equipment.

5.5.3.6.3 The operating system shall conform to ITU-T Rec. G.774 SDH informational model in managing the equipment. The operating system shall provide a versatile environment with automatic boot strap function for re-initialisation after a power interruption.

5.5.3.6.4 The NMS shall support Q interface conforming to ITU-T Rec. G.733, Q.811 & Q.812, Qecc interface as per ITU-T Rec.G.784 and F interface of V.24/V.28 type.

5.5.3.6.5 Each Management Terminal shall be equipped with 21 inch colour VDU to provide graphical representation and display of the network. A log printer shall be provided.

5.5.3.6.6 The mass storage device shall provide storage capacity for at least one month configuration and alarm data.

5.5.3.6.7 Each portable service terminal shall be powered by an internal rechargeable battery with more than 4 hours normal continuous time without recharging.

5.5.3.7 Cabling and Accessories

5.5.3.7.1 The optical fiber connectors shall comply with IEC60793 and IEC60874.

5.5.3.7.2 Optical fiber cable shall be out door type, armoured and comply with RDSO specs no. IRS: TC-55/2006 (rev. 1) or latest and procured from RDSO approved sources only.

5.5.3.7.3 The requirements on cabling accessories, digital distribution frames, optical distribution frames, main distribution frames shall be as given in Chapter 15 of this Particular Specification.

5.6 System Expansion

5.6.1 It shall be possible to insert additional SDH nodes into the OFC network without affecting the performance of the network, limits on this, if any, shall be specified by the Contractor for review by the Engineer.

5.6.2 It shall be possible to add in the OFC network more loops or rings each with upto 10 nodes for the WDFC phase II requirements without the need to replace the Central equipment. Adequate number of E1s and other data rate circuits including atleast one number of ADM1 shall be provided on the phase I OFC Communication system for cross connection with the phase II of OFC Communication system. The size of SDH nodes at stations and in OCC per clause 5.3.4.2 above shall take into account the requirements of phase II also.

5.6.3 The OFC network shall be upgradable to higher STM levels of transmission and larger transmission bandwidth without replacing the equipment.

5.6.4 The OFC shall be compatible with SDH equipment from other manufacturers.

5.6.5 The NMS for OFC shall be designed and equipped with all necessary hardware, software and capacity for future additional SDH equipment and associated multiplexers and channel interfaces.

5.6.6 It shall be possible to integrate the WAN/LAN of phase I provided by the contractor with the phase II system from any other manufacturer.

∗ End of Chapter 5 ∗

6 GSM-R MOBILE COMMUNICATION SYSTEM REQUIREMENTS

6.1 General

6.1.1 The Contractor shall provide GSM-R mobile radio transmission system with wireless voice and data communications channels to support the operational and maintenance requirements of WDFC.

6.1.2 The system shall be designed based on European Integrated Railway Radio Enhanced Network (EIRENE) Functional Requirements Specification (EIRENE FRS v7.3.0) and System Requirements Specification (EIRENE SRS v15.3.0) and RDSO Specification of Mobile Train Radio Communication System (GSM-R) No. RDSO\SPN\TC\88\2008 and latest. Only requirements for DFC are listed. Detailed description of each function can be found in EIRENE specifications. Decision regarding implementation of requirements marked as optional shall be taken by the Engineer during design stage.

6.1.3 The system will provide ground to train voice and data communication and vice versa, mobile communication needs of maintenance staff, track side workers, station and ELMD staff and railway administration and management staff.

6.1.4 The BTS and tower mounted antenna system at Rewari and Makarpura stations of phase I shall be designed, constructed and installed so as to provide adequate RF coverage towards phase II adjacent alignment also.

6.2 Scope of Work

6.2.1 Scope of Supplies

6.2.1.1 Scope of supply for the radio system shall include, but not be limited to the following:

(1) Base station Sub-systems (BSSs) including Base Transceiver Station, Base station Controller;
(2) Network and Switching Sub-system (NSS);
(3) Operation and Maintenance Centre (OMC);
(4) Dispatcher consoles and associated hardware for OCC and SCRs;
(5) Cab Radios and associated equipment for voice and data communication;
(6) Onboard devices interfacing with locomotive and diagnostic system;
(7) General purpose radios, Operational radios, Shunting radios
(8) Subscriber Identification Module (SIM) and associated writing computer system;
(9) antennae and support structure (towers) for base stations;
(10) lightning protection equipment;
(11) distribution frames;
(12) equipment cabinets, racks and cubicles together with mounting brackets and installation material;
(13) power supplies, cables, connectors, accessories, cabling and earthing for equipment and tower;
(14) all software and license required for operation and maintenance of the radio system;
(15) Simulation Tool for Radio Frequency planning/design;
(16) Any other item for fulfilling the requirements of this contract.

6.2.2 Scope of Services

6.2.2.1 The Contractor shall co-ordinate with Civil Works Contractors on requirements of station building. All the buildings shall be provided with concealed ducts/pipes for wiring of telecom facilities by Civil Works contractors The Contractor shall co-ordinate with the Civil Works Project Contractors to ensure the availability of proper duct/

pipes. Refer to Appendices 9-1 to 9-5 for other interface requirements with other project Contractors.

6.2.2.2 The Contractor shall liaise with all concerned authorities including WPC, SACFA, Civil Aviation authorities and other local authorities and obtain necessary clearances/sanctions for installation and commissioning of the Radio system. This shall also include liaising for obtaining the frequency clearance.

6.3 System Requirement

6.3.1 System Services

6.3.1.1 To meet DFCCIL operational requirements, Network shall support the following system services based on the EUROPEAN Telecommunication Standards Institute (ETSI) Global System for Mobile (GSM) Standards and additional requirements specified in EIRENE and Mobile Radio for Railway Network in Europe (MORANE) SRS documents:

(1) voice services:
- a) point-to-point voice calls;
- b) emergency voice calls;
- c) broadcast voice calls;
- d) group voice calls;
- e) multi-party voice calls;

(2) data services:
- a) text message bearer service;
- b) bearer service for general data applications;
- c) bearer service for automatic fax;
- d) bearer service for train control applications including driver safety device;
- e) bearer service for locomotive data transmission;

(3) call related services:
- a) closed user group;
- b) multi-level priority and pre-emption;
- c) advanced call handling, such as call hold, call transfer, call queuing, etc;
- d) auto answer service;
- e) barring incoming or outgoing calls;
- f) call supervisory indications;
- g) charging information;

(4) railway specific applications:
- a) support for functional addressing by train, engine or functional number;
- b) call specific persons depending upon user location (Location Dependant Addressing);
- c) specific mode for shunting operations providing a link assurance signal;
- d) multiple driver communications within the same train;
- e) railway operational emergency calls;

(5) direct mode facility for local set-to-set operation without network infrastructure ;

(6) railway specific features:
- a) set-up of urgent or frequent calls through single keystroke or similar;
- b) display of functional identity of calling/called party;

c) fast and guaranteed call set-up;
d) seamless communication support for train speeds up to 120 km/h;
e) automatic and manual test modes with fault indications;
f) control over mobile network selection; and
g) control over system configuration.

6.3.1.2 The voice call services except group calls shall be duplex and shall be able to operate between any combination of fixed and mobile equipment users.

6.3.1.3 The system shall support multi-party voice communication between upto six different parties. Any of the parties involved in multi-party voice call shall be able to talk simultaneously.

6.3.1.4 The network shall support point-to-point data communication. The network shall support data rates of atleast 2.4 k bit/s.

6.3.2 Encryption and Authentication

6.3.2.1 For securing the use of voice privacy encryption algorithms and authentication algorithms for SIM Cards shall be proposed and details furnished to the Engineer.

6.3.2.2 Use of standardized voice privacy algorithms is mandatory for the GSM-R network.

6.3.3 Numbering Plan and cell routing

6.3.3.1 Train controllers, station staff etc; will normally call a train by its running number rather than the Subscriber number associated with the mobile on the locomotive. On the other hand maintenance personnel in the ELMD will call the locomotive by its engine number. It is necessary to be able to call a train or the locomotive (within the ELMD) by functional numbers without knowing their subscriber numbers.

6.3.3.2 Contractor shall propose numbering plan compliant with EIRENE numbering plan bringing out principles of functional addressing, constraints, structure/format of Functional numbers, presentation of functional identity, details regarding Registration/deregistration/Re-registration etc. and submit to the Engineer for review and consent.

6.3.3.3 Numbering plan shall be consistent to be adopted as an Indian railway numbering plan. It shall meet railways all addressing requirements considering interoperability requirements.

6.3.3.4 An efficient implementation of the functional numbers shall be adopted from amongst the various options and details included in the submission to the Engineer.

6.3.3.5 The proposed mapping of the Functional numbers to subscriber numbers shall be flexible and future proof to allow the railway to develop and enhance the operations throughout the entire life of the network.

6.3.3.6 Network shall be implemented to support location dependent call routing. Location dependant addressing scheme shall be available to all mobiles. When operating with location dependant addressing, no manual action shall be required to update the system when a mobile moves between locations. It shall be easily possible to implement dynamic changes in controller area boundaries to match the railway organisation or the traffic demand. Details of the implementation shall be submitted to the Engineer for review and consent.

6.3.4 Cab Radio interface

6.3.4.1 A driver safety device (DSD) interface to the cab radio shall be provided in traction units in order to support the transmission of driver safety alarm.

a) The activation of the driver safety device shall automatically trigger the cab radio to send a data message to the Traffic Controller in the OCC.
b) The DSD alarm call / message shall provide the information on train number, engine number etc.
c) Contractor shall submit, as part of the Detailed Design, to the Engineer for review, the full details of all interfaces at the cab radio end and the traffic controllers RDW in OCC.

6.3.4.2 Interface with onboard Signalling System to transmit vital data and alarms of on board TPWS to OCC via radio link for display on terminals of TPWS maintainer in ELMD, Signal Fault Controller, Traffic Controllers, etc. These messages shall contain time and date stamp and train number.

6.3.4.3 The Contractor shall design the interface details with Signalling and submit to the Engineer for review as part of Detailed Design.

6.3.4.4 Cab radio shall interface with on board locomotive diagnostic and management system for transmission of vital data to OCC/DCC. Interface design shall be submitted as per requirements of Appendix 9-2.

6.3.5 Allocation of Priorities

6.3.5.1 At least five levels of priority shall be defined. The order of priority for different type of calls shall be implemented with the approval of the Engineer. Cab radios and the Controller's consoles in OCC and in SCRs shall be configured for all priorities for various situations.

6.3.5.2 To ensure interoperability priorities shall be allocated consistently across different networks.

6.3.5.3 Lowest priority call shall be pre-empted before that of a higher priority.

6.3.5.4 Railway Emergency call shall have the highest priority.

6.3.6 Call Restriction

6.3.6.1 Various types of call restrictions may be employed by the Employer as an additional security measure. Call restriction facility shall be available and implemented as required by the Engineer. Implementation of such call restrictions shall not affect interoperability.

6.3.7 Group Membership

6.3.7.1 A mobile may be a member of a number of groups. It shall be possible to 'activate' or 'deactivate' the mobile's subscription to these groups.

6.3.7.2 Activating a group on the mobile shall allow a user to receive a call from that group. Deactivating a group on the mobile shall prevent the user to receive calls from that group.

6.3.7.3 In order to provide interoperability, cab radios will be members of a number of standard groups:

a) Railway emergency calls,;
b) All train drivers; and

c) Shunting team.

6.3.7.4 All mobiles with railway emergency group call subscription(s) shall be prevented from deactivating the emergency group(s) whilst operational.

6.3.8 Access matrix

6.3.8.1 The Radio System shall as a minimum support the communication between various parties in accordance with the following matrix:

6.3.8.2 System Voice Call Requirements Matrix

		OCC	SCR (DFC)	Train Radio	Hand portable	DCC	PABX extension	SCR (IR) OPH
Voice Calls	OCC (Various controllers)		yes	yes	yes	Yes		Yes
	SCR (DFC)	Yes	Yes	Yes	yes	Yes ***		Yes
	Train Radio	Yes	Yes	Yes	yes	Yes*	Yes*	Yes****
	Hand portable	Yes	Yes	Yes	yes	Yes	Yes **	
	PABX extension			Yes*	Yes **			
	DCC	Yes	Yes***	yes*	yes			
	SCR(IR) OPH		Yes	Yes****	Yes			

Tabel 6-1 Voice call requirement matrix

Yes indicates that the calls shall be allowed.

*- Calls authorised by OCC

** -Calls between designated radios & designated PABX extensions

***Calls from DCC to limited SCRs decided by the Engineer.

**** Limited Access to be decided during design

6.3.8.3 Voice call requirement matrix in table 6-1 is very tentative. Contractor shall develop the access matrix in consultation with the Engineer and submit the same to the Engineer for review and approval.

6.3.9 Mobile Equipment

6.3.9.1 The four standard main type of terminals are required. These terminals shall fulfil basic services, facilities and features as specified in EIRENE specification. The Contractor shall provide these mobile radio types:

(1) Cab radios for the transmission of voice and non-safety data – for use by the driver of a train and/or by other on-train systems;
(2) General purpose radios – for general use by railway personnel;
(3) Operational radios – for use by railway personnel involved in operations such as trackside maintenance; and

(4) Shunting radio - for use by railway personnel involved in train operations such as shunting.

6.3.9.2 It shall be possible to operate all mobiles in the frequency bands around 900 MHz, allocated for use by the Railways and in the public GSM frequency bands.

6.3.9.3 Mobile equipment shall function correctly when travelling at speeds from 0 km/h to 120 km/h.

6.3.9.4 All terminals shall be of following power classes:

Radio Type	Power Class	Power (W)
Cab Radio	2	8
General purpose radio (handheld)	4	2
General purpose radio (vehicle based)	2	8
Operational radio (handheld)	4	2

Table 6-2 Definition of power classes for each radio type

6.3.9.5 Services and Facilities :

6.3.9.5.1 The following call related / Supplementary services are to be supported for each type of mobile radio:

- Display of calling user identity
- Display of called user identity
- Restriction of display of user identity
- Multi Party Service (MPTY)
- EIRENE Closed user group (CUG)
- Call forwarding
  - Unconditional
  - If user busy
  - If no reply
  - If not reachable
- Call hold
- Call waiting
- Call barring
- Unstructured Supplementary Service Data (USSD)
- Follow me
- Sub-addressing
- Enhanced Multi-Level Precedence and Pre-emption (eMPPL)
- Explicit Call Transfer (ECT)
- Completion of Calls to Busy Subscribers (CCBS)
- User-to-User Signalling 1 (UUS 1)
- Auto answer service
- Call supervisory information

6.3.9.5.2 The following EIRENE features are to be supported for each type of mobile radio:

EIRENE Features	**Cab Radio**	**General Purpose Radio**	**Operational Radio**

Functional addressing	M	M	M
Location dependent addressing	M	O	O
Direct mode	O	O	O
Shunting mode	M	NA	M
Multiple driver communications within the same train	M	NA	NA
Railway emergency calls	M	O	M

M = Mandatory O = Optional N/A = Not applicable

Table 6- 3 EIRENE specific features to be supported

6.3.9.6 Cab radio

6.3.9.6.1 The driver is proposed to be provided with a handheld portable to allow communications while the cab radio is not working or whilst the driver is outside the train.

6.3.9.6.2 Following functions as a minimum shall be performed by the cab radio and the driver MMI:

Driver call related functions:

a) call controllers as configured;
b) call other drivers in the area;
c) send railway emergency call;
d) confirm receipt of railway emergency call;
e) communicate with other drivers on the train;
f) call train staff;
g) call other authorized users;
h) receive incoming voice calls;
i) terminate calls;
j) receive text messages;
k) enter/leave shunting mode;
l) enter/leave direct mode, Optional;
m) monitor calls to other on-train users/devices;
n) Forward calls/cancel call forwarding to/from driver handheld, Optional;

Other driver related functions:

a) powering up radio;
b) switch radio MMI on and off;
c) select language (Indian language to be included);
d) adjust loudspeaker volume;
e) select mobile radio network;
f) register and de-register train number;
g) register and de-register stock number;
h) store retrieve numbers and their details;
i) invoke supplementary services;
j) invoke tests

Other cab radio functions:

a) automatic connection of incoming calls to appropriate on train users or devices;

b) automatic establishment of outgoing calls initiated by on-train users/devices;
c) automatic handling of calls of varying allocated priorities;
d) send to the controller(s) a signal on activation of driver safety device;
e) transmit railway emergency call event indication to “train borne recorder” provided by the contractor RS P-7;
f) run time diagnostics;

6.3.9.7 General purpose radio

6.3.9.7.1 Following functions as a minimum shall be performed by the General purpose radio:

Call related functions:
a) call authorized users;
b) receive incoming calls;
c) group and broadcast calls; and
d) terminate calls;

Capability of sending and receiving railway emergency calls shall be reviewed during detailed design.

Other functions:
a) switch radio on/off;
b) select language;
c) select mobile radio network;
d) adjust loudspeaker volume;
e) register and de-register functional numbers; store / retrieve numbers and their details, and
f) computer interface

6.3.9.8 Operational radio

6.3.9.8.1 Following functions as a minimum shall be performed by the Operational radio:

Call related functions:
a) call authorized users;
b) send railway emergency calls;
c) receive railway emergency calls;
d) receive incoming calls;
e) group and broadcast calls; and
f) terminate calls;

Capability of direct mode calls shall be reviewed during detailed design.

Other functions:
a) switch radio on/off;
b) select language;
c) select mobile radio network;
d) adjust loudspeaker volume;
e) register and de-register functional numbers;
f) store / retrieve numbers and their details; and
g) computer interface.

6.3.9.9 Shunting radio

6.3.9.9.1 The shunting radio shall comply with the requirements as for operational radio modified by the requirements for shunting. Additional requirements not limited to the following shall be complied:

a) shunting radio shall support shunting mode;
b) means to enter/leave shunting mode shall be provided;
c) it shall be possible to change shunting group number within 5 second;
d) audio and visual alarm for low battery indication; and
e) Link assurance signal facility to be available for all types of communication in shunting mode.

6.3.9.10 MMI requirements :

a) A service availability indication shall be provided to radio users as defined in EN301515, index 26.
b) The user shall be prevented from entering direct mode if the GSM R service is available.
c) If an attempt to establish Railway emergency call is not successful after 2 seconds, an indication shall be provided to the user of the status of the establishment request procedure.

6.3.9.10.1 The contractor shall furnish, as part of the detailed design, full details of the MMIs and each of the functionalities, for all types of mobile radios listed above.

6.3.9.11 Out of Range Indication

6.3.9.11.1 In an idle mode if the GSM Service indicator is lost, the mobile shall give an audible and visual indication. The audio and visual indication shall remain until the radio moves back into the coverage range.

6.3.9.11.2 If a radio emergency call set up from the radio is unsuccessful, the radio shall automatically re-attempt the call set up until the call setup is successful, a retry time of 30 seconds expires or the user abandons the call.

6.3.9.12 Environmental and physical requirements of all mobile radios

6.3.9.12.1 General

1) All mobile equipment shall comply with all environmental, EMC and physical specifications defined in GSM Standard especially with reference to EN 301489 part 1 and part 7 and EN 301 515 Index 2 and 35.
2) All mobile equipment shall conform to EN 60950 (Safety of Information Technology Equipment), including Electrical Business Equipment 1993 plus amendment A1 and A2.
3) All design, Manufacturing, testing and installation of mobile radio equipment shall comply with the quality procedures defined in ISO 9001.

6.3.9.12.2 Climatic Conditions

1) Mobile equipment shall be capable of operating over a temperature range of -10°C to +55°C without any permanent damage.
2) Equipment shall be capable of coping with temperature variation of up to +/- 1° C/minute.
3) Mobile equipment shall be capable of operating between altitudes of -100m to 1800m, referenced to sea level.
4) Equipment shall be capable to cope with relative humidities of 100% for short periods, yearly average 75%. Equipment shall also cope with 95% humidity for 30 days in the year.
5) Operationally caused infrequent and slight moisture condensation shall not lead to any malfunction or failure.
6) Mobile equipment shall not degrade photochemically when exposed to solar radiation of upto 1200 W/ m^2.

7) In normal operation of mobile radio unit it shall be expected that a combination of the above environmental conditions will be experienced.

6.3.9.12.3 Mechanical Conditions

1) All mobile equipment shall be protected against shock and vibration in compliance with standards defined in EN 50155 using tests defined in EN 50155.
2) All handheld mobile equipment shall withstand non-repetitive shocks of upto 3g for upto 100ms under normal conditions and protected against free fall from 0.5m.
3) All mobile equipment shall be capable of being subjected to both sinusoidal and random vibration.
4) Handheld mobile equipment shall be capable of withstanding the following levels of continuous sinusoidal vibration:

- Frequency range: 5-200 Hz;
- Peak to peak amplitude: 7.5 mm;
- Peak acceleration: 1.5g.

5) The random vibrations to be withstood by mobile equipment shall be 0.25g in all three axes of freedom.

6.3.9.12.4 Electrical

1) For determining battery requirements, the transmit/receive duty cycle used shall be as shown below for each call type:

Call Type	Transmit	Receive
Point to point call	100%	100%
Group Call	30%	100%
Broadcast Call (originated)	100%	100%
Broadcast Call (receive)	0%	100%

Table 6-4 Transmit receive duty cycles for different call types

2) Battery requirements shall be provided without the use of discontinuous reception or transmission (DTX / DRX).
3) Battery requirement shall be met based on full power during transmission and location updating.

6.3.9.12.5 Electromagnetic Compatibility

1) Transmission of EM radiation from all mobile equipment shall comply with the radio frequency transmission masks defined in EN 301 515, index 35 for the range of GSM frequencies.

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2) The emission and immunity standards for the general railway environment and ancillary services as defined in EN 50121 parts 1, 2, 3-2 and 4 shall be considered.

3) The electromagnetic emission generated by the mobile train radio system shall not interfere with the normal operation of any on-train or ground-based system as listed hereunder :

a) Signalling relays and contacts;
b) speedometers
c) Power transformers
d) track circuits

e) axle counters
f) train describers
g) other radio equipment
h) radar speed measurement equipment
i) switched mode power supplies
j) telecommunications circuits
k) electronic locking systems

6.3.9.12.6 Testing Procedures

1) The environmental and physical tolerance of the mobile radio units shall be tested at a facility in accordance with EN ISO/IEC 17025.
2) All EMC emission and immunity test shall be performed in accordance with guidelines defined in EN 61000 Part 4-3.
3) Environmental testing procedure shall follow guidelines defined in IEC 60068 part 1.
4) Specific environmental test procedures to be followed for mobile equipment shall include tests on Cold, Dry heat, Damp heat (cyclic), Impact, Vibration, Acceleration, Corrosive atmospheres, Air pressure, change of temperature and fire hazard, as defined in IEC 60068 .

6.3.9.13 Train mounted equipment including the Cab radio terminal equipment, MMI and antenna shall comply with all specifications as in clause 6.3.9.12 and its sub-clauses and all those defined herein below, with those listed below taking priority.

6.3.9.13.1 Environmental and physical requirements (additional) for cab radio

Climatic Conditions		
1	Cab radio operating temperature range	-10°C to +70°C
2	Operating temperature range for aerial and other equipment mounted outside the cab	-10°C to +70°C
3	Temperature fluctuations for aerial & other equipment mounted outside cab	up to 3° C/second
4	Pressure gradient for aerial & other equipment mounted outside cab	Pressure gradient up to 100 kPa / s and in tunnel pressure pulses of 6 KPa (peak to peak) for upto 3 seconds
Physical Conditions		
5	SIM card shall be physically integrated with the radio set to be removed	only by maintenance staff
6	protection against theft	physical protection, alarms, access control measures
Mechanical Conditions		
7	Ingress of water and dust protection	IEC 60529 (IP54) for MMI
8	Maximum level of Sinusoidal Vibration for equipment inside train cab	5 – 200 Hz amplitude peak to peak 7mm Acceleration: 1.5g
9	Maximum level of Sinusoidal vibrations for equipment mounted outside the train	5-1000 Hz Peak to peak amplitude 5mm Acceleration: 2.5g

Electrical		
10	Cab radio shall comply with	EN 50124
11	emergency power supply shall be provided for cab radio in the event of failure of train's main power supply	for atleast 1 hour backup based on duty cycle point to point calls 20%, group calls 5% and standby 75%
12	cab radio main and backup power supply shall comply with voltage fluctuations and transients	as defined in EN 50155
13	the driver and other in cab equipment shall be protected against all electrical hazards arising from mobile equipment	as defined in EN 50153
Electromagnetic Compatibility		
14	Electromagnetic interference immunity and emission of the cab radio shall comply with	EN 50121 parts 1, 2 and 3-2
15	Emissions from the cab radio and its associated antenna system shall comply with	EN 50121 parts 1, and 3-2
Testing Procedures		
16	Cab radio shall pass electrical tests	as defined in EN 50155

Table 6-5 Environmental and physical requirements (additional) for cab radio

6.3.9.13.2 The cab radio shall be provided with sufficient filtering and suppression circuit to immune radio interference from the driving cab electronics etc. Contractor shall interface with the RS P-7 for requirements of EMI and EMC and submit, to the Engineer for review, the jointly agreed interface document covering all interface issues.

6.3.9.13.3 The cab radio shall be installed in air-conditioned enclosure in the locomotive cab. RS P-7 and ST P-5 Contractors shall jointly analyse the requirements of the air-conditioning.

6.3.9.13.4 Two identical input power supplies (voltage to be specified by RS P-7 contractor) from electric locomotive power supply in main and hot standby mode of operation shall feed the cab radio unit. The switchover from the main to hot-standby power supply shall be transparent and not cause any loss in communication to the radio users. Contractor shall use converters, if required, to power the train radio and associated equipment. The Contractor shall liase with RS P-7 Contractor to determine the characteristics of the electric locomotive power supply and provide necessary switching, converters and protection from expected levels of spike and interference voltages. Cables and wiring shall be adequately screened.

6.3.9.14 Driver Man-Machine Interface

6.3.9.14.1 Driver Man Machine Interface shall comprise of the following components:

- display;
- control panel;
- loudspeaker;
- handset with push –To-Talk button.

6.3.9.14.2 Radio equipment installed in a driver's cab shall not obstruct the driver's vision or otherwise hinder the safe driving of the train.

6.3.9.14.3 Layout of the equipment in the cab shall be decided in coordination with the RS P-7 contractor and submitted to the Engineer for review and consent..

6.3.9.14.4 All call related functions except talking shall be possible with the handset on or off the hook.

6.3.9.14.5 The driver shall be able to adjust the brightness of buttons, indicator lights and display according to the ambient lighting in the cab.

6.3.9.14.6 The driver shall be able to adjust the contrast of the display.

6.3.9.14.7 The emergency call button shall be red and shall be protected against accidental use.

6.3.9.14.8 Any displays shall be clearly readable from a normal driver's position, assuming a normal reading distance.

6.3.9.14.9 Display characters shall have a minimum height of 5mm.

6.3.9.14.10 MMI shall be splash proof and suitable for viewing in direct sun light and in darkness.

6.3.9.14.11 Cab radio shall prevent tempering.

6.3.9.14.12 If contact with the mobile radio network is lost, then the cab radio shall give an audio and visual indication.

6.3.9.14.13 Driver Man-Machine interface shall be installed in the leading and also the trailing cabs of each locomotive.

6.3.9.14.14 Facilities shall be provided to support a list of stored names /numbers of upto a minimum of 100 entries.

6.3.9.14.15 Abbreviated dialling facility shall be supported.

6.3.9.15 The operational Hand-portable (OPH) shall comply with all specifications as in clause 6.3.9.12 and its sub-clauses for mobile radios and all those defined herein below, with those listed below taking priority.

6.3.9.15.1 Environmental and physical requirements (additional) for Operational Hand-portable radio

Climatic Conditions		
1	OPH to cope with rapid temperature fluctuations	up to 3°C/second
2	Exposure to extreme environmental conditions comply with	EN 300019
Physical Conditions		
3	Ingress of water and dust protection	as a minimum comply with IP54 (EN 60529)

4	SIM shall be fixed to the radio set such that	Can only be removed with the help of a tool
Mechanical Conditions		
5	semi-sinusoidal shock	up to 5g for up to 100ms under normal conditions and upto 10g for upto 5 ms in exceptional conditions; - free fall from 1.0m
Electrical		
6	OPH user shall be protected against all electrical hazards arising from mobile equipment	as defined in EN 50153
7	OPH battery capability	Rechargeable battery over the temperature range of -10°C to +55°C from a single charge shall be capable of eight hours for duty cycle of point to point calls 20% + group calls 60% + standby 20%.
Electromagnetic Compatibility		
8	Operational radio should comply with	EN 61000 part 6-2 and part 6-4 (generic EMC for industrial environment)

Table 6-6 Environmental and physical requirements (additional) for OPH

6.3.9.15.2 Changing the battery shall not result in the loss of stored data;

6.3.9.15.3 OPH radio shall be suitable for use with a car adaptor kit;

6.3.9.16 The Shunting radio or a combination of Shunting radio and accessories shall comply with the requirements applicable to the Operational radio modified by the requirements listed below:

6.3.9.16.1 Auxiliary interface connector(s) shall be provided to support various voice, control and other functions.

6.3.9.16.2 The auxiliary interface shall support as a minimum the following functions:

- Control panel:
  a)emergency button;
  b)push to talk;
  c)Link assurance;
  d)Alerting of controller;
  e)Shunting group selector;
- Loudspeaker;
- Microphone;
- Antenna connection direct or coupled;
- Data;
- Power output for low power consuming accessory;
- Charging connector; and
- Headset

6.3.9.16.3 Shunting radio shall support shunting mode communications.

6.3.9.16.4 Shunting radio or a combination of Shunting radio and accessories shall be capable of operating over temperature range -10°C to +55° C display working properly and extreme conditions -10°C to +70°C display may slow but the functionality remains.

6.3.9.16.5 The Shunting radio or a combination of Shunting radio and accessories shall comply with protection standard EN 300 019. The lower class defined in this standard shall

be fulfilled as a minimum. Higher classes shall be examined during detailed design stage.

(1) The shunting radio accessories should comply with dust and water protection standards according to IP 65 (EN 60529)or higher.

6.3.9.17 General purpose Handportable Radio (GPH):

6.3.9.17.1 The full environmental and physical specifications of the GPH shall be as close as possible to that of Commercial-Off -The –Shelf (COTS) GSM mobile whilst adhering specifications as listed in clause 6.3.9.12 and its sub-clauses above for all mobiles and for handhelds and complying with the following:

6.3.9.17.2 SIM shall be fixed to the radio set to protect against accidental loss.

6.3.9.17.3 General purpose radio shall be equipped with rechargeable batteries capable of providing a minimum of eight hours operation over the temperature range +18°C to +25° C from a single charge, based on the duty cycle point to point calls 20% + group calls 5% + standby 75%.

6.3.9.17.4 Changing the battery shall not result in loss of data stored in the radio.

6.3.9.17.5 General purpose radio shall be suitable for use with a car adapter kit.

6.3.9.17.6 General purpose radio should comply with EN 61000 part 6-1 and part 6-3 (generic EMC for residential, commercial and light industry).

6.3.10 Network Management

6.3.10.1 General

6.3.10.1.1 The Radio Management System shall be a centralised control system with Management Workstation, system database, log printer and mass storage device to be co-located with MSC at the CER at OCC.

6.3.10.1.2 A database shall be built for defining the system hardware and software configuration. Any change in the database shall be automatically updated on mass storage device.

6.3.10.1.3 Network configuration management shall provide functions to exercise control collect and provide information to the network elements. Typical functions offered shall include, but not limited to the following:

1) Provisioning element configuration, status and control.
2) Subscriber management- individual subscribers and subscribers in groups.
3) Data management etc.

6.3.10.2 Performance management

6.3.10.2.1 Performance management shall provide data concerning the performance of the radio system and individual channels with respect to traffic volume so as to optimise the system configuration, equipment deployment, user grouping and future sizing of the system.

6.3.10.2.2 Performance management shall produce statistical reports on the channel usage and system performance. It shall have the facility to monitor base station channel traffic on real time basis. It shall allow flexible adaption of traffic configurations to the dynamic traffic requirements.

6.3.10.3 Security Management

6.3.10.3.1 The security management functions shall be, but not limited to the following:

1) Definition of different levels of permitted access to network nodes and network functions by specific authorised personnel.
2) Supervision and maintenance of access control routines.
3) Access control to network management services.
4) Security logs

6.3.10.4 Fault and Alarm Management

6.3.10.4.1 Fault and Alarm Monitoring shall be capable of the following:

1) Capable of monitoring system alarm status on real time basis.
2) Store the alarm details in the database for future enquiries and to access the fault alarm history database for retrieval of alarm history data.
3) In addition to the alarms and status to be shown on the management workstation, the status of major equipment shall be monitored and displayed with visual indications to the local radio equipment racks.

6.3.10.5 Alarm Handling

6.3.10.5.1 Functions for alarm supervision shall include, but not limited to the following:

1) Supervising individually the functionality of each system up to Base Station level, including monitoring and control of transfer links, power supplies, and other equipment
2) Performing fault recognition in real time
3) Investigation and localisation of failures up to FRU level

6.3.10.5.2 The following alarm conditions shall be provided to the radio management system as a minimum:

1) loss of communication links;
2) loss of master clock synchronisation;
3) failure of power supply unit;
4) changeover to redundant central equipment;
5) base station health status;
6) central equipment health status;
7) low power and no power alarms for all transmitters; and
8) indication of receiver failures;

6.3.10.5.3 All failure alarms shall be time and date stamped.

6.3.10.5.4 The failure alarms shall be classified into major or minor alarms by the radio management system and be user configurable.

6.3.10.5.5 Visual and audible indications shall be available for any failure alarm reported to the radio management system. The audible indication shall be enabled and disabled through the radio management system Workstation.

6.3.10.5.6 The alarm log shall display the following as a minimum:

a) Description of The Alarm;
b) time and date of the alarm generated;
c) The alarm history database shall be provided with sufficient capacity to store the reported alarms for a period of at least four weeks without carrying out any housekeeping function.

6.3.10.6 Alarm Displays

6.3.10.6.1 The Contractor shall provide the following general capabilities and characteristics for the alarm display as a minimum:

1) the ability to quickly filter the alarm display to view alarms generated from a particular system component or by a geographic location;
2) a colour coding scheme indicating the alarm severity according to the alarm classifications and alarm priority levels;
3) the display of the alarms in chronological order along with their associated time stamps;
4) the facility to acknowledge alarms.

6.3.10.7 System Management Printer

6.3.10.7.1 The radio management system shall be equipped with a common maintenance printer for the production of hard copies of graphical screen information, system parameter data, maintenance fault history, listing of pre-defined system information and various performance management reports. The maintenance printer shall be connected to the radio management system Workstation.

6.3.10.8 Field Programming

6.3.10.8.1 All the radios including base station, hand portable radio and Cab radio shall have a port for field programming and diagnostic access through a notebook computer.

6.3.11 Dispatchers console (Radio Dispatcher's Workstation – RDW)

6.3.11.1 System wide control of railway operations is generally carried out from the OCC. Following complement of controller positions are planned in OCC for phase-1 and phase 2 of WDFC:

S.No.	Description	Positions for		Total
		Phase 1	Phase 2	
1	Chief Controller	1	0	1
2	Deputy Chief Controller	1	0	1
3	Traffic Controller	3	2	5
4	Asstt Controller (Train clerk)	1	0	1
5	Crew/TLC Controller	1	0	1
6	Engineering Controller	1	0	1
7	Signal Fault Controller	1	0	1
8	Telecom Fault Controller	1	0	1
9	Chief Traction Power Controller	1	0	1
10	Traction Power Controller	2	1	3

6.3.11.2 Each of the controllers in the OCC shall be provided with a dispatcher's console as per Appendix 3 MMI provision schedule.

6.3.11.3 One RDW with restricted access shall also be provided in the Central Equipment Room at OCC for the Telecommunication Systems. This unit shall be used for maintenance monitoring and shall work as spare for RDWs in the OCC.

6.3.11.4 Functionalities and features of RDW

6.3.11.4.1 Functionalities of Dispatcher console MMI not limited to the following shall be provided:

(1) queue all incoming calls or call request showing the functional identity and priority of caller;
(2) emergency call shall be identified and presented on top of all calls in the queue and shown in different colour/flashing followed by calls in order of priority;
(3) controller can select any of the calls from the queue in any order he likes;

(4) controller can establish railway emergency call or railway operation priority call to any mobile by selection from the display;
(5) to make, close, enter and leave group calls;
(6) send and receive text messages;
(7) transfer its call to another dispatcher's console;
(8) if a railway emergency call is not answered it shall automatically be transferred to the chief controller or any other controller's console as decided by the Engineer;
(9) The Chief Controller shall have the provision of taking over the functions of any of the Traffic Controllers in their absence.; and
(10) Patch radio call to PABX/PSTN subscriber.

6.3.11.4.2 Following features as a minimum shall be provided for the RDW:

1) Standard PC – Latest with suitable operating system, LCD Display
2) Call set up by functional number
3) Ordered list of multiple incoming calls
4) Call priority handling
5) Call hold / restore
6) Call transfer
7) Leaving and Terminating Incoming Calls
8) Train Position updates
9) Dynamic user configuration
10) User selectable language

6.3.11.4.3 Controller equipment should provide facility for recording of all speech and data calls sent from and received by the RDW. The recordings shall be maintained for a period of three weeks before being overwritten. The recording system shall have availability of 99.99%. It shall be possible to transfer the recorded speech and data calls to removable archive CD/DVD and USB etc for long term storage.

6.3.11.5 For station operational control, SCR shall be provided with a Fixed Radio Terminal with communication facilities covering the area in his jurisdiction. The fixed radio terminal at SCR will incorporate a GSM(R) Radio with outdoor antenna. Contractor shall detail the functionalities and features of the proposed Fixed Radio Terminal. The fixed radio terminal equipment should provide facility for recording of all speech and data calls sent from and received by the terminal. The recordings shall be maintained for a period of three weeks before being overwritten. The recording system shall have availability of 99.99%. It shall be possible to transfer the recorded speech and data calls to removable archive CD/DVD and USB etc for long term storage.

6.3.12 Telephone Interconnect Call

6.3.12.1 Designated Hand portable radios shall have the capability of initiating or receiving telephone calls from designated telephones directly without the Controller's intervention.

6.3.12.2 Controller's console shall have the facility to connect to a telephone subscriber PSTN/EPABX as telephone interconnect call. By a three party conference it shall be possible for the controller to patch a radio user and a land line telephone subscriber, not authorized to make telephone interconnect call.

6.3.12.3 Normally all radio users shall be barred from receiving incoming telephone calls or from making outgoing telephone calls. Designated radio users shall only be allowed the facility of telephone interconnect calls. Telephone interconnect calls from/to

unauthorised radio/telephone users shall be rejected. Contractor shall submit full details in this connection.

6.3.13 Coverage and performance

6.3.13.1 For network planning, the coverage, level is defined in terms of time and area where the minimum signal criteria are achieved. The level of coverage shall be at least 95% of the time over 95% of the designated coverage area for a radio installed in a vehicle with an external antenna. The network shall support all EIRENE-compliant mobiles. The land-based part of the system shall provide communications for mobiles when stationary and when travelling at speeds up to 120km/h.

6.3.13.2 The proposed WDFC alignment generally runs parallel to the existing alignment of Indian Railways (IR)

6.3.13.3 The Radio System shall cover, but not be limited to the following:

(1) all station control rooms, equipment rooms, plant rooms, administrative areas, ancillary buildings, and any other areas where the operation and maintenance staff may gain entry;
(2) along each railway track in the entire DFC defined in this contract;
(3) within each depot (ELMD, IMD, Sub IMD, Service buildings) area including all rooms, sheds and open area up to the boundaries of the depot;
(4) IR stations and yards connected to the junction stations of WDFC.
(5) all on-line TSSs, SPs, SSPs, ATSs, Level Crossing gates, Signal and Telecommunication equipment rooms/cabinets, etc;
(6) within a minimum distance of 250 meters on both sides from centre of tracks along the entire WDFC alignment;
(7) all parts of OCC building complex and DFCCIL Headquarters; and
(8) residential quarters at all WDFC stations etc.

6.3.13.4 The requirements of verification, testing and commissioning are given in Chapter 13 In addition the Contractor shall conduct continuous radio frequency signal strength test following the pre-determined paths given by the Engineer. The Contractor shall submit the signal strength measurements as part of the Partial Acceptance Test Results of the radio system to verify contract compliance for both Up-link and Down-link signals. Train equipped with measuring tools shall be used to measure and optimise settings at low and high speeds.

6.3.13.5 Quality of service parameter as measured shall be compared with the designed parameters. After optimisation if any the final GSM(R) network shall be fully compliant to the requirements of the design and the PS. Results of the final train run test shall be submitted to the Engineer for review and approval.

6.3.13.6 Indoor RF signal strength/coverage shall be measured and results submitted to the Engineer for review. To improve the indoor coverage additional measures shall be taken by the contractor if so required.

6.3.13.7 All radio communications between Dispatchers in OCC, DCC and SCRs and with other radio users, as detailed in Clause 7.5.4, shall be recorded by the Voice Recording System (VRS) of the Telephone System located in the equipment room in OCC.

6.4 Performance Specifications

6.4.1 General

6.4.1.1 In addition to what has been specified in Chapter 3 the following performance requirements for the Radio system shall be complied:

6.4.2 Reliability Requirements

6.4.2.1 The Contractor shall furnish for the following sub-systems/equipment, the reliability figures, MTBF Hours from the OEMs:

(1) MSC sub components
(2) Base Station Controller (BSC)
(3) Base Transceiver Station (BTS)
(4) Operation Maintenance Centre (OMC)
(5) Dispatcher Console (RDW)
(6) Cab Radio
(7) Fixed Terminal Radio Equipment for SCR
(8) General Purpose Radio (GPH)
(9) Operational Radio (OPH)
(10) Shunting Radio
(11) Any other equipment forming part of the system.

6.4.3 Availability Requirements

6.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the Radio system shall not be included in the determination of the system availability.

6.4.3.2 The conditions which shall be considered as failures shall include, but not be limited to:

(1) failure to initiate individual voice call
(2) failure to initiate Voice group call
(3) failure to initiate railway emergency call
(4) failure to initiate shunting emergency call
(5) failure to initiate Voice broadcast call
(6) failure of Location Dependant Addressing
(7) failure of Functional Addressing
(8) failure of any one base station causing gap in RF coverage
(9) failure of MSC equipment
(10) Dispatcher Terminal (RDW) unable to receive a call

6.4.3.3 The Radio system shall have an overall availability of better than 99.99%.

6.4.3.4 The Network Management Sub System shall be considered unavailable if any of the functions provided by the system cannot be properly exercised. The availability of the Network Management Sub System shall be better than 99.95%.

6.4.4 Maintainability Requirements

6.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

6.4.4.2 Service life of the Radio system/equipments shall not be less than 15 years.

6.4.5 System Safety Requirements

6.4.5.1 All equipment must comply with, and be installed in conformance with IEC 60065 , IEC 60950 and IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

6.4.5.2 All metallic enclosures shall be provided with an earth terminal and connected to earth.

6.4.6 Interoperability requirements

6.4.6.1 System will comply with the interoperability requirements for mobile equipment (cab radio and hand portables between EIRENE specified other GSM-R networks of DFCCIL supplied by other vendors.

6.4.6.2 The main objective is to allow trains travel as a minimum in the different Dedicated Freight corridors, under the jurisdiction of DFCCIL, with a seamless radio communication service.

6.4.7 Call set-up time requirement

6.4.7.1 Call set-up time requirements are dependent mainly upon priority. The requirements for end-to-end call set-up performance are indicated in the table below:

S.N	Call type	Call set-up time
1	Railway emergency calls	<2s*
2	Group calls between drivers in the same area	<5s
3	All operational mobile-to-fixed calls not covered by the above	<5s
4	All operational fixed-to-mobile calls not covered by the above	<7s
5	All operational mobile-to-mobile calls not covered by the above	<10s
6	All low priority calls	<10s

Table 6-7 Call setup time requirements

6.4.8 The required call set-up times shall be achieved in 95% of cases. Call set-up times for 99% of cases shall not be more than 1.5 times the required call setup time. Set-up times shall include the time required for any translation of functional numbers internal to the EIRENE network. Call setup times shall be achieved with authentication and ciphering procedures enabled.

6.4.8.1 Emergency calls may use fast call setup procedures bypassing authentication and ciphering procedures. All other calls setup time (except group calls) as defined in EIRENE FRS shall be achieved with authentication and ciphering procedures enabled.

6.4.9 Handover and cell selection

6.4.9.1 The call hand-over between the RF coverage zones of different base stations shall be, flawless and guaranteed at speeds of 0 to 120 Kmph, transparent to the radio users and shall not drop / interrupt on-going calls regardless of their type and mode.

6.4.9.2 Quality of service (QOS) requirement is that the call hand-over execution time shall not exceed 300 milliseconds, which is measured as the time taken when the radio detects a signal strength below a pre-defined level to establishing communication using an adjacent base station site providing the new channel. A break of 7s shall be unacceptable.

6.4.9.3 The handover success rate shall be at least 99.5% over train routes under design load conditions as given in EN 301515 Index30.

6.4.9.4 The contractor shall submit details of the hand-over process as a part of the detailed design.

6.4.10 Broadcast and group call areas

6.4.10.1 The group or broadcast call area used will have the effect of determining which mobile can participate in the call It shall be possible to determine the area over which the call takes place by one, or a combination, of the following:

- the location of the call initiator (if mobile originated);
- the identity of the group being called (eg. All users, all trains, etc)

6.4.10.2 Any group or broadcast calls initiated in a given location shall be broadcast over an associated area base on the location of the call originator, and also to any fixed network numbers associated with the originating location.

6.4.10.3 Mobiles configured for reception of railway emergency calls entering into a call area where a railway emergency call is ongoing shall automatically join this call.

6.5 Technical Requirements

6.5.1 General

6.5.1.1 The system architecture shall be based on European Telecom Standard Institute (ETSI), Global System of Mobile (GSM) Phase 2 standard. The main components of the system are:

1) Base Station Sub-system - base station controllers (BSCs) are to be installed at OCC or at location approved during design. Base transceiver stations (BTSs) shall be installed at stations and along the entire route of WDFC for adequate RF coverage as per this specification.

2) Network sub-system(NSS) interface to the BSS via the GSM 'A' interface: The NSS containing mobile services switching centers (MSCs) with primary responsibility for call control is to be installed in OCC or any other location as approved during design. The MSC is supported by a Visitor Location Register (VLR) containing temporary details of subscribers active within the MSC area, a Group Call Register (GCR) containing attributes of voice group and broadcast call configurations for the related MSC area and Home Location Registers (HLRs) holding subscribers details on a permanent basis. MSC shall be provided with IN platform based on CAMEL (Customised Application for mobile enhanced logic) latest version.

3) The network shall also support General Packet Radio Service (GPRS) infrastructure elements supporting the respective packet radio services in future.

4) The network shall be compatible to interface with the following networks:
   - PSDN – Packet Switched Data Network (INET) etc.
   - Public Land Mobile Network.

5) Mobile equipment interfacing to the BSS.

6) Subscriber Identity Modules (SIM) containing information specific to single subscriber.

7) Operation and Maintenance center (OMC) for managing the network.

6.5.1.2 All major equipment and component of the Radio System shall have redundant engineering to minimize the effects of the failure of such equipment to the operations and performance of the Radio System.

6.5.1.3 The Mobile switching centre (MSC) shall be highly reliable, fault tolerant and capable of supporting non-stop on line call processing. The central switch equipment shall be provided with a hot standby with automatic changeover in the event of a failure of the working unit. MSC changeover between main and hot standby shall occur with minimum interruption to the call processing, so that an on-going call is not disrupted. Mobile Switching Centre shall be fully wired for the capacity of 6000 subscribers and as a minimum expandable upto 20000 subscribers.

6.5.1.4 Redundant routing shall be adopted for all fixed telecommunication links and redundant equipment shall be installed within critical components e.g. additional redundant cards at the BSC/TRAU. Activation and where necessary re-configuration of redundant equipment shall be possible in the live environment.

6.5.1.5 Radio calls between the Traffic Dispatcher and Train Driver shall have two priorities, viz. normal and emergency. During normal train regulation, normal priority radio calls shall be established. When there is an emergency incident, the Traffic Dispatcher and Train Driver shall be able to make emergency radio call which shall have a higher priority in channel allocation.

6.5.1.6 Different types of radio calls shall have different priorities. The priority of different types of calls shall be user configurable using the maintenance terminal in OCC.

6.5.1.7 Software shall be designed to accommodate the ultimate, fully expanded capacity, without requiring any change to the hardware or firmware of the installed system and without adversely affecting the overall operation or performance of the Radio system.

6.5.1.8 The Contractor shall supply the following mobile radio equipment under this contract:

1) 360 (Three Hundred sixty) sets of OPH complete with accessories;
2) 360 (Three Hundred sixty) numbers of spare batteries for OPH;
3) 1297 (One Thousand Two Hundred Ninety Seven) GSM R SIM cards for use with normal GSM mobile sets (GSM mobile sets are excluded from supply under this contract);
4) 132 (One Hundred Thirty Two) sets Cab radio complete with accessories.
5) 132 (One Hundred Thirty Two) numbers of spare batteries for Cab radio.

6.5.1.9 OEM's original specifications (data sheets) and other configuration details as a minimum for all equipment listed below shall be submitted with the Preliminary/Detailed design submissions for review and consent by the Engineer:

(1) all sub-component of Base station Sub-systems (BSSs) including Base Transceiver Station, Base station Controller etc;
(2) Network and Switching Sub-system and associated sub systems;
(3) Operation and Maintenance Centre (OMC);
(4) Power supply system
(5) dispatcher consoles and associated hardware for OCC and SCRs
(6) cab radio complete with antenna & MMI;
(7) Operational Purpose radio (OPH);
(8) General purpose radio (GPH);
(9) shunting radio;
(10) Antennas of various types proposed in the detailed design.
(11) Subscriber Identification Module (SIM) and;
(12) all other equipments, including requirements for interfacing with other sub-systems and other project contractors, forming part of the radio system.

6.5.1.10 System shall be safe in operation and shall not place users at risk.

6.5.1.11 Software management and control requirement shall be as detailed in the GS.

6.5.1.12 Base Station radio equipment shall work from 48 volt DC battery backup system. The Central Infrastructure equipment shall work from 230 V AC 50Hz single phase power supply from the common S&T Power Supply System (PSS) being provided by the contractor.

6.5.2 Frequency Planning

6.5.2.1 The system shall operate within the frequency band 952.8-954.4/907.8-909.4MHz.

6.5.2.2 The use of radio frequency spectrum in India is regulated by the Wireless Planning and Co-ordination (WPC) Wing of the Ministry of Communications, Government of India. The employer has been authorised the use of eight frequency pairs in band 952.8-954.4/907.8-909.4MHz for mobile train radio communication. However, a separate clearance for the use of specific frequencies is to be obtained. Based on the frequency plan proposed by the Contractor, approval from WPC shall have to be obtained. The Contractor, if so required by the WPC, shall incorporate specific changes in the frequency plan, after mutual discussions.

6.5.2.3 In case more frequencies are required for implementation of the system for WDFC then the same shall have to be arranged by the Contractor from WPC without time implications to the Employer.

6.5.2.4 The radio system shall be designed for DMO channels as well. DMO voice calls shall be possible both ways between a cab radio and another cab radio, cab radio and hand-portable and between two hand-portables located within a radius of approximately 2 km. Any additional equipment/accessories as required shall also be supplied.

6.5.2.5 The Contractor shall perform radio frequency planning ensuring efficient use of the available frequency pairs. The frequency plan including detailed calculations shall be submitted to the Engineer for review, as part of the Design.

6.5.2.6 The system design shall have suitable safeguards to ensure that the operation of a radio set from any other system is debarred, and its operation does not affect the operation of Radio System of WDFC in any way.

6.5.2.7 Frequency planning calculations shall ensure that there will be no interference from frequencies within the system and from other radio communication links operating in the same band of frequencies in the entire service area of WDFC radio system. Remedial action to overcome the interference if any required shall be taken by the contractor. RF coverage plots to show that there will be no interference from frequencies within the system shall also be submitted. Contractor shall submit carrier to interference ratio (C/I) and received signal quality (RxQual) capturing the bit error rate (BER). C/I value shall be more than 15 dB and RxQual value shall be 3 or better..

6.5.2.8 Simulation Tool used for frequency planning shall be provided as part of the scope of supply. The Tool shall also be capable of Radio coverage simulation, both indoor and outdoor. It is preferred that the Tool shall be a Windows based COTS product, so that future support is assured. Details of the proposed simulation tool shall be submitted to the Engineer for review.

6.5.3 Radio Frequency Coverage

6.5.3.1 For network planning the coverage level is defined as the field strength at the antenna on the roof of a train (nominally a height of 4m above the track). An isotropic antenna with a gain of 0dBi is assumed. This criterion will be met with a certain probability in the coverage area. The following minimum values shall apply :

- coverage probability of 95% based on a coverage level of 41.5 dBµV/m (-95 dBm) on lines with ETCS levels 2 for speeds lower than or equal to 120 km/h;

6.5.3.2 RF link budget shall also be designed to provide satisfactory indoor and outdoor coverage for hand portable radios for all areas as specified in clause 6.3.13.3, for which an extra margin should be considered for a minimum coverage level of -88 dBm at 1.5 m above terrain outdoor.

6.5.3.3 The specified coverage probability means that with a probability value of at least 95% in each location interval (length:100m) the measured coverage level shall be greater than or equal to the figures stated above.

6.5.3.4 Inter BTS distance shall not exceed 7 Km.

6.5.3.5 RF coverage and Quality of Service shall be designed for future implementation of ETCS level 2 for speeds lower than or equal to 120 Km/h.

6.5.3.6 Network shall be planned with an appropriate radio network planning tool and an appropriate propagation model for the terrain being covered. Details of the tool and the methodology adopted shall be given.

6.5.3.7 In the event of failure of any one radio base station, fault tolerant RF coverage (for cab radio) of the affected area shall be provided by the radio base stations on either side of the failed base station and the cab radios shall experience coverage gap almost approaching 0 Km.

6.5.3.8 Contractor shall submit detailed link budget analysis and RF Signal coverage plots both for up-link and the down link for cab radio and handheld (indoor and outdoor coverage) for each base station, to confirm that the required RF coverage stated above can be achieved using the Contractor's proposed antenna system and their locations. Assumptions like dense urban, urban and sub-urban etc. and the specifications of the base station equipment including TX/RX, RF cables, splitters, directional couplers, antenna etc. and the specifications of Mobile equipment adopted for link budget calculations shall be detailed.

6.5.3.9 Coverage in the two way communication is decided by the weakest transmission direction. It is therefore necessary to balance the up and down paths.

6.5.3.10 Diversity reception shall be provided for protection against failure in receive antennas or receiver multi-couplers and to provide gain in the Up-Link path.

6.5.3.11 Radio system shall be synchronised with the timing signal from the Master clock. Contractor shall submit detailed synchronisation plan including fall back arrangements.

6.5.3.12 The radio system shall have tower mounted antennae for wide area coverage.

6.5.3.13 The contractor shall submit the particulars of locations of radio base station sites, requirements of antenna and aerial support structure (radio towers) necessary to provide the specified area coverage throughout the WDFC network indicating full indoor and outdoor coverage as specified above.

6.5.3.14 Voice and data channels for telephone and SCADA are required to be provided at each of the TSSs, SPs, SSPs and ATSs of the traction supply distribution system. GSM-R base stations along with SDH nodes, at locations other than stations, shall preferably be located as close as possible to the locations of TSSs, SPs, SSPs and ATSs.

6.5.3.15 Telephone communication is required to be provided at all the railway level crossing gates. GSM-R base stations as far as possible shall be optimized and preferably located as close as possible to the locations of railway level crossing gates.

6.5.3.16 A minimum of one GSM-R base station shall be located at each of the crossing and junction station and if necessary at OCC of phase I of WDFC.

6.5.3.17 Base Transceiver Stations (BTSs) shall be linked to the BSC through a logical ring network structure as given in drawing NKC-S&T-SSD-AL-20008 (version A) in Employer's drawings, so that link failure on one side shall not affect the availability of the mobile network in any way. The BTS-ring will be realised through 2 Mb/s transmission circuits forming the ring. All interconnections forming the ring, being BTS-BTS or BTS-BSC shall be realised in a separate geographical/physical route compared to all other interconnections within the specific BTS-ring.

6.5.3.18 The logical BTS-ring structure shall provide protection switching for all Abis channels between BTS and BSC. BTS shall have dual ports for connection in the ring configuration. A maximum of 4 BTSs shall be allowed in one logical ring.

6.5.4 System Radio Channel Requirements

6.5.4.1 The Radio system shall not provide traffic blocking exceeding 1%. Traffic calculations considering all radio communication needs of fixed and mobile radio subscribers to establish these requirements shall be submitted as part of detailed design. Requirements of radio communications during emergencies and crisis management should also be considered.

The Radio system shall support the following modes of traffic as a minimum:

(1) Normal traffic, this shall be the communication between radios under the RF coverage zone of the same base station.
(2) Inter-base station traffic, this shall be the communication between radios under the RF coverage zones of different base stations.
(3) Emergency traffic shall be the communications during emergency operations.

6.5.4.2 Radio system shall as a minimum be equipped with 15 (14) traffic channels and 1 (2) control channel at every BTS.

6.5.5 Cab Radio DC/DC Converter Requirements

Input Voltage	:	to be ascertained by interface with RS P-7 contractor
Output Current	:	ST P-5 to indicate requirement
Ripple Factor	:	ST P-5 to indicate requirement
Other Protection	:	Short-circuit protection
	:	Over voltage protection

: Overload protection
: Self recovery
: More to be specified by the contractor

6.5.6 Built-in Test Routine

6.5.6.1 Built-in test routines shall be able to test the cab radio and the radio MMI. These routines shall operate in an off-line mode to allow a complete functional test of the module in problem.

6.5.6.2 The Contractor shall ensure that upon every initialization cab radio shall perform automatic self-diagnostic routine test on the all Train borne radio Communication Equipment. An audible tone shall indicate the readiness state of the Train Radio Communication System and associated equipment.

6.5.6.3 The fault and self-diagnostics information shall be processed and sent to the dispatcher's console (specific RDW to be decided during design) to indicate the status of the cab radio to facilitate prompt fault diagnosis and enable DFCCIL staff to locate faulty modules for first line replacement.

6.5.6.4 The cab radio shall be provided with a radio test port to enable full specification testing. The port shall be able to interface to a Notebook Computer. The selection of functions and data to be monitored shall be menu driven by the Notebook Computer. The data indicating the cab radio's performance shall be displayed in an informative and comprehensive manner. Information shall be presented graphically where possible. The Contractor shall provide a full description of cab Radio performance functions to be monitored, as well as those which are not monitored.

6.5.7 Run Time Diagnostics

6.5.7.1 The cab radio shall be capable of performing a suite of runtime diagnostic tests on all physical interfaces.

6.5.7.2 Failure of an interface shall be reported to the driver via the display on the MMI indicators.

6.5.7.3 All failures shall be recorded in the activity log at OCC.

6.5.7.4 Diagnostic tests shall not interfere with normal operation of the cab radio.

6.5.8 Train borne Antenna

6.5.8.1 The antenna shall be mounted suitably on the roof of the electric locomotive to meet the required performance specifications without causing any electromagnetic interference to other equipments on board the Train. The contractor shall interface with the contractor RS P-7 for location, type and fixing of the antenna.

6.5.8.2 The Contractor shall submit the drawings showing the placement of the antenna on the roof of the electric locomotive. The low profile antenna on the roof of the electric locomotive shall not infringe the schedule of dimensions.

6.5.8.3 The antenna and mounting brackets shall be extremely rugged low profile design and shall withstand the effects of washing plants, mechanical vibration, dust accumulation and other physical hazards typical of railway environments.

6.5.8.4 Where applicable, the antenna feed shall consist of pre-terminated, double screened, flexible, 50 Ohm, RF feeder cable. The feeder routing shall be designed to avoid effects of EMI.

6.5.8.5 The orientation and placement of the antenna on the roof of the electric locomotive shall ensure minimum VSWR and maximum coupling of RF signal.

6.5.8.6 Cab Radio Antenna Requirements

6.5.8.6.1 Cab radio antenna shall as a minimum comply with requirements of Shock and vibrations etc. Contractor shall submit to the Engineer for review complete specifications/OEM's datasheets of cab radio antennas considered in the RF coverage design.

6.5.9 Antenna Towers at Radio Base Stations

6.5.9.1 The towers shall be designed and constructed for working and installation in the geographical and environmental conditions over the entire route of WDFC.

6.5.9.2 All towers shall comply with the requirements of Standard EIA/TIA-222-E and Indian Standard IS-800, 808, 226/2062, 1367, 1161, 2629, 5358. In case of any conflict between the two standards, the Indian Standards shall prevail. Contractor shall always immediately seek advice from the Employer / Engineer in the event of conflict.

6.5.9.3 The towers shall be self-supporting steel structure.

6.5.9.4 All steel used shall be hot dip galvanised in full compliance with the relevant ISO or ASTM specifications or IS 4759. The galvanised tower members shall further be treated suitably to protect from rusting.

6.5.9.5 Any damage to the galvanising during the erection shall be made good by the Contractor before acceptance by the Engineer.

6.5.9.6 The towers shall be designed to withstand a minimum wind load of 200 kmph or the maximum wind speed of the concerned zone as currently defined by the Indian Meteorological Department (whichever is higher) while supporting the maximum number of antennae plus two additional antennae required of the same type/size, located at full height.

6.5.9.7 For design purposes, the combined projected area of these antennae shall be maximised against the wind direction.

6.5.9.8 The tower loading as a minimum must take into account the wind load, seismic conditions, load of antenna, antenna support structures, live load of installation and maintenance staff, all tower accessories and at least 100% safety margin against structural failure for the actual anticipated configuration.

6.5.9.9 The Contractor shall design/build/erect the base/foundations/earthing/fencing of the tower. It is expected that the foundations can be constructed from standard concrete and reinforcing steel. However, the Contractor shall ensure the adequacy of the soil bearing pressure to support the weight of the tower including all accessories, antennae, antennae support structures and live load of installation and maintenance staff and to resist the overturning moments generated in the survival wind speed. During construction of the Tower foundation, the Contractor shall be responsible for the safety of the site and the structures nearby. The earthing design shall be as per IS 3043 or better standard for Radio Towers and the foundation and earthing design shall be got approved by the Engineer before implementation.

6.5.9.10 A rest platform with guard railing and seat every 20 m. and a 400mm wide climbing ladder with 20 mm diameter rungs at intervals of 300 mm to the top of the tower shall be provided. Design of ladder, the platforms and the tower shall also consider the live load of a number of installation/maintenance personals at different levels. Working platforms at the levels where antennas are installed shall be such that these will facilitate installation and maintenance personal to work on the antennas without any additional supports and without any undue risk.

6.5.9.11 The ladder shall be securely and rigidly fixed so that the tower faces form a safety cage. Backward tilt shall not be acceptable.

6.5.9.12 The linear and torsional sway of the tower under the worst loading conditions shall be restricted to a value such that no degradation of system performance is experienced.

6.5.9.13 All tower connection nuts and bolts shall be made of steel conforming to the requirements of IS 6639, IS 13634 or ASTM A-325 or an equivalent international standard, and shall be hot dip galvanized. Lock nuts shall be provided and installed for all bolts without exception.

6.5.9.14 All towers shall be equipped with a suitable cable rack to house the feeder cable to antenna, and cable clamps of suitable design shall be provided and installed.

6.5.9.15 The towers shall be equipped with Aviation Warning Lights in conformity with the relevant requirements of ICAO.

6.5.9.16 Pockets and depressions likely to hold water shall be avoided, and where unavoidable, shall have suitable draining facility.

6.5.9.17 For earthing of the tower, holes of suitable diameter shall be made near the base of the tower. At least two earths at adequate distance apart interconnected shall be provided. The earth resistance shall be less than one ohm under all weather conditions.

6.5.9.18 The tower shall have lightning conductors of appropriate design and size, which shall be earthed through dedicated copper conductors of suitable cross section coming down from the top of the tower to the base of the tower to be grounded.

6.5.9.19 Contractor shall submit the tower structural design, the foundation design and other details to the Engineer for review and consent.

6.5.9.20 Life of the tower shall be at least 40 years.

6.5.9.21 A means of preventing unauthorised access onto the ladder shall be provided.

6.5.10 Base Station Outdoor Antenna

6.5.10.1 The outdoor antenna shall be of robust construction utilising corrosion resistant aluminium alloy and shall be protected from lightning. The feeder cable connection shall be weatherproof and fully sealed. Contractor shall submit complete specifications/OEM's datasheets of various types of base station antennas considered in the RF coverage design.

6.6 System Expansion

6.6.1 The radio system design shall cater for modular expansion at all hardware locations to accommodate future requirements and/or upgrades without the need for replacement

of the installed hardware and software during the equipment lifetime. Expansion / up gradation of the radio system shall be possible by addition of modules, cards/sub-racks and additional licenses for additional base stations. The contractor shall submit to the Engineer the expansion capability of various equipments and sub-systems for review.

6.6.2 The central switch and all equipment installed in the CER shall meet the requirements of expansion to cover the phase 2 of WDFC and over and above provide additional capacity of 25% or expansion requirements as specified in clause 6.5.1.3 whichever is higher.

6.6.3 The radio dispatcher system shall be designed to provide atleast 10 additional radio dispatcher workstations (RDW) in OCC for requirements of phase 2 of WDFC.

∗ End of Chapter 6 ∗

7 ELECTRONIC PABX REQUIREMENTS

7.1 General

7.1.1 The Administrative Telephone System shall provide the voice communications between locations equipped with telephone sets within the DFCC premises and other defined locations.

7.1.2 Electronic Private Automatic Branch Exchange (EPABX) shall be provided as the Administrative Telephone System for the operation, maintenance and administrative staff to set up voice communication.

7.1.3 Locations to be equipped with telephone sets shall include station buildings, depots (IMD), sub-depots (IM Sub-depot), OCC, offices and WDFC residential buildings etc. Refer to Appendix 1 for tentative locations and quantities of telephones at stations.

7.2 Scope of Works

7.2.1 In addition to what has been stated in chapter 2 the scope of works shall be as given below.

7.2.2 Scope of Supply for the Telephone system shall include, but not be limited to the following:

1) PABX switches;
2) line and trunk interfaces;
3) telephone sets;
4) PABX management system;
5) centralised voice mail system;
6) centralised voice recording system;
7) power supply equipment, cables and accessories;
8) distribution frames, cabinets, enclosures, racks; and
9) any other items to complete the scope of the works;

7.2.3 Scope of Services

7.2.3.1 The Contractor shall co-ordinate with Civil Works Contractors on requirements of station buildings. All the buildings shall be provided with concealed ducts/pipes for wiring of telecom facilities by Civil Works contractors The Contractor shall co-ordinate with the Civil Works Project Contractors to ensure the availability of proper duct/ pipes. Refer to Appendix 9-3 for other interface requirements with Civil Works Contractors.

7.3 System Requirement

7.3.1 A highly reliable digital telephone main and satellite exchange system shall be installed to provide communications to digital and analogue telephone sets throughout WDFC. The Contractor shall discuss with the Engineer to agree on the exact quantity and location of each type of telephone sets. The PABX switch network shall provide feature transparency across all the PABX switches throughout WDFC.

7.3.2 Satellite exchanges shall be provided at the stations. Main switch shall be provided either at OCC or any other location in consultation with the Engineer. The subscriber telephones at other locations practically not feasible with copper cables shall be provided through Optical Fiber cables.

7.3.3 The link between the Main Switch and the Satellite Switches shall be using digital trunk lines at E1.

7.3.4 The switch shall have connection to the Public Switched Telephone Network (PSTN). This shall allow pre-selected extensions to access the PSTN or vice versa.

7.3.5 A digital Voice Recording System (VRS) shall be provided in OCC to record all telephone and radio conversations of all controllers in OCC, ELMD and stations.

7.3.6 A centralized or decentralized Voice Mail System (VMS) shall be provided and integrated with the Switch to enable PABX users to leave, retrieve and broadcast voice messages to and from this single message centre.

7.3.7 A Network Management Computer with a workstation, system database, logging printers and mass storage devices shall be provided in the network management room of OCC. A management PC and printer for local management functionality shall be provided in each of the other PABXs at stations.

7.3.8 Surge protection shall be provided in each switch.

7.3.9 The PABX switch network shall provide feature transparency across all the PABX switches throughout WDFC. The following PABX features shall be provided:

(1) Automatic Call Back;
(2) Break-in;
(3) Busy Hunt;
(4) Call Forward;
(5) Call Park;
(6) Call Party Name Display;
(7) Call Pickup;
(8) Call Transfer;
(9) Call Waiting;
(10) Conference Call;
(11) Hot line
(12) Abbreviated dialling
(13) Access paging
(14) Attendant recall
(15) Alternative route selection
(16) Forced release
(17) Line lockout
(18) Malicious call trace
(19) Recorded announcement
(20) Direct Inward Dialling (DID);
(11) Direct Outward Dialling (DOD);
(22) Distinctive Ringing;
(23) Do Not Disturb;
(24) Last Number Redial;
(25) Music On Hold;
(26) Speed Dial; and
(27) Voice Mail.

7.3.10 The EPABX Network shall support closed homogeneous numbering plan across the network such that the user has to just dial the extension number of the user, he wishes to reach from anywhere in the network. The contractor shall accordingly design the numbering plan and submit to the Engineer for approval.

7.3.11 The EPABX switch network shall support a minimum of the following four levels of programmable restrictions to each telephone extension:

(1) totally restricted level which user cannot make or receive calls to and from the PSTN through the telephone extension;
(2) semi-restricted level which user cannot make PSTN calls but can receive PSTN calls through the attendant console telephone/DID;
(3) local level which the telephone extension user can make or receive local PSTN calls only and
(4) unrestricted level which there shall be no restriction on the telephone extension for call connection.

7.3.12 The assignment of the class of services and features to any telephone extension shall be user configurable. DID, DOD and voice mail shall only be provided to pre-selected groups of staff or telephones.

7.3.13 The EPABX switch network shall be connected to the GSM® Radio system to provide switching and connection for designated user to make telephone call connection through the hand portable/train mobile radios and call to hand portable/train mobile radios through designated telephone extension. This facility shall be programmable.

7.3.14 EPABXs at stations and OCC equipped as a minimum not limited to the following shall be supplied, installed and commissioned:

S.N	Description of Item	EPABX TYPE S1	EPABX TYPE S2	EPABX TYPE S3	EPABX TYPE S4
1	Equipped Ports (numbers)	256	256	128	48
2	Wired Ports (numbers) with licenses	512	256	256	96
3	Expandable Ports (numbers)	512	256	256	96
4	Management PC + Printer for entire telephone network of WDFC (central NMS)	at OCC only	-	-	-
5	Management PC for local functionality.	1 (Except OCC)	1	1	1
6	Analogue telephones (numbers)	85% of Total Nos.	85% of Total Nos.	85% of Total Nos.	85% of Total Nos.
7	Analogue feature telephones (numbers)	10% of Total Nos.	10% of Total Nos.	10% of Total Nos.	10% of Total Nos.
8	Digital telephones (numbers)	5% of Total Nos.	5% of Total Nos.	5% of Total Nos.	5% of Total Nos.
9	Ports for CO lines	4	2	2	1
10	E1/PRI for DID lines	1	1	1	1
11	VOIP Facility	Yes required	Yes required	Yes required	Yes required

Note: For Tentative quantities of telephones and locations of Type S1, Type S2, Type S3 and Type S4 EPABXs refer to details in Appendix 1

7.3.15 Each telephone switch shall be powered by 48 V battery back-up system provided by the contractor.

7.4 Performance Specification

7.4.1 General

7.4.1.1 In addition to what has been specified in Chapter 3 the following performance requirements for the telephone system shall be complied:

7.4.1.2 Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

7.4.2 Reliability

7.4.2.1 The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

7.4.2.2 The Contractor shall furnish for the following sub-systems/equipment, the reliability figures, MTBF Hours from the OEMs:

(1) Switching module of the PABX switch
(2) Processor module of the PABX switch
(3) Memory module of the PABX switch
(4) Line and trunk Interface module of the PABX switch
(5) Power supply equipment
(6) NMS Workstation

7.4.3 Availability Requirements

7.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the telephone system shall not be included in the determination of the system availability.

7.4.3.2 The availability of the connection between any PABX extensions shall be better than 99.99%.

7.4.3.3 The PABX management system shall be considered unavailable if any functions provided by the PABX management system cannot be properly exercised. The availability of the PABX management system shall be better than 99.95%.

7.4.3.4 The centralised voice mail system shall be considered unavailable under any one or combination of the following conditions:

(1) message cannot be recorded into the centralised voice mail system when the voice mail box of the affected user is not full;
(2) message cannot be retrieved by the user; and
(3) corruption of voice message stored in the centralised voice mail system.

7.4.3.5 The availability of the centralised voice mail system shall be better than 99.95%.

7.4.3.6 The centralised voice recording system shall be considered unavailable under any one or combination of the following conditions:

(1) messages cannot be recorded into the centralised voice recording system;
(2) messages cannot be retrieved from the centralised voice recording system; and
(3) corruption of voice message stored in the centralised voice recording system.

7.4.3.7 The availability of the centralised voice recording system shall be better than 99.99%.

7.4.4 Maintainability Requirements

7.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

7.4.4.2 The service life of the telephone system (equipment) shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years..

7.4.5 System Safety Requirements

7.4.5.1 The Subsystem shall not present any safety hazard to the operation and maintenance persons.

7.4.5.2 All equipment must comply with, and be installed in conformance with IEC60065 IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

7.4.5.3 All metallic enclosures shall be provided with an earth terminal and connected to earth.

7.5 Technical Requirement

7.5.1 EPABX Switch Network

7.5.1.1 The system shall provide non-blocking connection for extension calls within the same switch. The telephone system shall offer a fully integrated and transparent digital service acting as a single digital switch. For calls through trunks or tie lines, the system shall provide a GOS of 1% for PABX services for the following traffic intensity during an average busy hour under normal condition without traffic overflow:

(1) DID trunk traffic intensity at 1.5 HCS per extension;
(2) CO outgoing trunk traffic intensity at 1.5 HCS per extension;
(3) Traffic intensity of 18 HCS per digital extension;
(4) Traffic intensity of 6 CCS per analogue extension;
(5) 25% of the station traffic intensity assumed to use tie lines; and
(6) Traffic intensity of 1.5 HCS per voice-mail system user assumed to use tie lines.

7.5.1.2 The Contractor shall carry out traffic estimation calculations and analysis for each PABX switch and submit to the Engineer for review and consent.

7.5.1.3 Redundancy for the important interfaces/ modules such as power supply, processor etc. shall be provided. The EPABX network shall be designed such that there is redundancy and diversity in terms of the communication links for call routing and call establishment. An indicative block diagram is shown in drawing number NKC-S&T-SSD-AL-20009 (VERSION-B) in Volume V Reference Drawing.

7.5.1.4 The system design shall ensure high system availability with minimum common mode failure allowing graceful degradation.

7.5.1.5 Network and system shall be resilient to failure providing automatic reconfiguration of equipment with minimum system loss in particular the avoidance of common mode failure of site equipment, Optical fiber cable and power supply and software affecting system operation.

7.5.1.6 Failure of any one PABX switch shall not affect the communication between all other PABX switches.

7.5.1.7 Failure of E1 linkage between any two PABXs shall not affect the inter PABX communication.

7.5.1.8 Network architecture shall be future proofed to accommodate in the flexible manner enhancements to equipments and systems with respect to hardware and software upgrades.

7.5.1.9 EPABX switch network shall be synchronised to the master clock signal for merging into a single synchronised network along with the Optical Fiber Communication system. The EPABX switch network shall have internal clock in free running mode in the event of the failure or absence of the master clock signal. The slip allowable in the exchange network shall confirm to ITU-T Rec. G.822. A highly resilient telephone network synchronisation scheme shall be developed possibly employing multiple fall back protection and details furnished to the Engineer for review.

7.5.1.10 The telephone system shall have the capacity of ringing up to minimum of three telephone sets connected in parallel.

7.5.2 EPABX Switch Specifications

7.5.2.1 The Telephone System shall conform to applicable ITU-T standards.

7.5.2.2 The extension line interface in the exchange equipment shall match analogue or digital extension equipment as required and fulfil the following requirements :

(1) loop resistance of subscriber connected on physical cable pairs shall be limited to 1200Ω.The minimum value of the leakage resistance of the line shall be 20 K Ohms;

(2) shall connect long distance subscriber lines up to 10 Km on PIJF telephone cable; and

(3) the exchange line shall block the extension line after certain period of “Off-Hook” condition without a selection being received. This period shall be between 10 and 20 seconds. Busy tone shall be sent to the blocked extension;

7.5.2.3 The digital extension line equipment shall be capable of data transmission simultaneously with speech (ISDN working).

7.5.2.4 All software and configuration data operating the EPABX switch shall be stored in non-volatile memory and shall not be corrupted or lost in case of EPABX failure or loss of power supply.

7.5.2.5 Three types of telephone sets shall be provided for staff communications:

(1) Analogue telephone sets with
  (a) DTMF keypad;
  (b) 4 feature keys, last number redial key, hook flash, mute and hold;
  (c) lamp for message waiting;
  (d) power supplied by the PABX System;

(2) Analogue feature telephone sets with
  (a) DTMF keypad;
  (b) adjustable volume control;
  (c) lamp for message waiting;
  (d) 4 feature buttons for redial, hook flash, mute and hold;
  (e) a minimum 10 function keys for flexible assignment for system features;
  (f) a minimum 10 memories for speed dialling;
  (g) hands free operation through built in loudspeaker and microphone;

(h) on hook dialling;
(i) power supplied by the PABX System;

(3) Digital telephone sets with
(a) dial keypad;
(b) display unit showing calling and caller's name and extension for incoming; and outgoing calls
(c) ringing signal lamp;
(d) voice mail message lamp;
(e) on-hook dialling function;
(f) hand free operation through built-in speaker and microphone;
(g) adjustable volume control for speaker and ringer;
(h) a minimum of 10 programmable function keys for flexible assignment for; system features or additional extension circuits
(i) display of call duration;
(j) system clock display;
(k) a minimum of 20 Memories for speed dialling;
(l) powered by the EPABX;

7.5.3 Voice Mail System (VMS)

7.5.3.1 The VMS shall enable internal and external telephone users to access specific mailboxes using the following peripherals:
(1) analogue telephones using DTMF;
(2) digital telephones;
(3) CO outgoing trunks and DID trunks; and
(4) digital trunk;

7.5.3.2 Telephone users assigned with VMS shall have a unique voice mailbox which shall be password protected.

7.5.3.3 The VMS shall support 5000 users for 24 hours a day. The system shall be expandable to 6000 users. The ports connecting to the system shall support traffic intensity offered by 5000 users in such a way that 1% GOS shall be achieved. VMS shall provide storage for a total of not less than 240 hours of voice menu and message.

7.5.4 Recording System (VRS)

7.5.4.1 The VRS shall provide recording of telephone conversations of all controllers as well as the audio signals of Radio System. It shall be a digital system providing sufficient capacity for recording up to 3 weeks before being overwritten. The VRS shall comply with the requirements as given below.

7.5.4.2 VRS shall record all DTS calls of all controllers in the OCC, the ELMD and the stations. It shall also record all two way radio calls (except DMO calls) not limited to the following:
(1) all Private Radio Calls between any type of Radios;
(2) all emergency calls and broadcast calls from any type of radios;
(3) all group calls;
(4) DTS telephone calls to radios and
(5) any other type of radio calls except DMO calls;

7.5.4.3 The VRS shall have the facility to transfer the recorded audio to removable archive CD/DVD and USB etc. for long term storage.

7.5.4.4 VRS shall be synchronised with the Master Clock system. All recorded conversations shall be date and time stamped with maximum deviation of 2 seconds.

7.5.4.5 VRS shall be built by an array of identical modules with 1+1 protection.

7.5.4.6 The VRS shall automatically changeover to the standby module within 1 second for the standby unit to become active and start recording under the following conditions:

(1) pre-scheduled daily changeover from the active to the standby module;
(2) whenever fault is detected on the active module which affects the normal recording;

7.5.4.7 Alternatively normal and standby units of (1+1) VRS shall record the audio signals of DTS and the radio systems in parallel simultaneously. The storage shall be for 3 weeks per clause 7.5.4.1 above for each of the normal and standby units.

7.5.4.8 The VRS shall support simultaneous recording and playback or change recording medium without disrupting the on-line recording.

7.5.4.9 The VRS shall provide facilities for user to place a marker on the recording medium to mark any conversation on any channel or any combination of channels at any time.

7.5.4.10 The VRS shall provide search function for user to locate any part of the recording medium in terms of:

(1) date and time;
(2) by channel;
(3) search by marker placed by the user and;
(4) by User ID;

7.5.4.11 The VRS shall provide automatic gain control for voice message recording.

7.5.4.12 The contractor shall determine the number of recording channels and size the VRS and submit to the Engineer for review and consent. Spare recording capacity to the extent of 20% shall be provided.

7.5.4.13 Following functions, as a minimum, shall be provided through the Workstation connected to the VRS:

(1) audio monitoring of any channel under recording or playback mode;
(2) recording medium movement control including playback, fast forward, fast backward, record, stop and pause; and
(3) recording medium shall indicate the recording time elapsed and the free capacity available for further recording.

7.5.4.14 The VRS shall comply with the following specifications:

1	wow and flutter	:	$\leq$ 0.8% peak
2	frequency response	:	300 to 3400 Hz within $\pm$ 3 dB;
3	Signal to noise ratio	:	> 42 dB;
4	Cross talk immunity	:	> 60 dB at 1 KHz;
5	Distortion	:	< 3%
6	Automatic gain control level	:	$\pm$3 dB in recording level for all input

7.5.5 Network Management System

7.5.5.1 The Network Management System shall provide control, supervision and maintenance functions for the entire Telephone System. The following management and administrative functions shall be provided through the use of the centralized maintenance console:

(1) user Data Management;
(2) fault Monitoring;
(3) performance Management;
(4) call Detail Recording;
(5) voice Detail Recording;
(6) configuration Management;
(7) application Program Interface;
(8) accounting Management;
(9) maintenance History Management;
(10) system Diagnostics;
(11) remote Access;
(12) data Logging; and
(13) remote Alarm Monitoring;

7.5.5.2 Access to the telephone network management system shall be password protected.

7.5.5.3 Failure in the telephone network management system shall not affect the normal operation of the EPABX network.

7.5.5.4 Laptop pre-loaded with appropriate software shall be used to access the local maintenance port of the EPABX for system administration and management.

7.5.6 Block Wiring

7.5.6.1 All the voice circuits from the EPABX switch shall be terminated at the Main Distribution Frame inside the TER for distribution of the internal and external lines and interface with relevant sub systems and project contractors. The circuit termination shall be of IDC (Insulation Displacement Contact) type. All the wired ports shall be terminated on the MDF.

7.5.6.2 All the data circuits from the EPABX switch shall be terminated at the Digital Distribution Frame inside the TER for distribution of the internal and external lines and interface with relevant sub systems.

7.5.6.3 Multicore telephone cables shall be provided and connected from the distribution frames inside the TER to the distribution frames at the MDF for connection between the EPABX switch and the trunk circuits of PSTN. The interface between the Telephone system and the PSTN circuits shall be at the MDF.

7.5.6.4 Telephone distribution boxes shall be provided and installed at suitable locations for intermediate distribution of the circuits from the EPABX switch.

7.5.6.5 Multicore telephone cables shall be provided and connected from the distribution frames inside the TER to the intermediate telephone distribution boxes. A minimum of 25% spare capacity in all telephone cables, Main Distribution Frames and Intermediate Distribution Frames shall be reserved for future expansion.

7.5.6.6 Standard RJ-11 modular socket shall be provided for termination of the telephones via plug and socket arrangement.

7.5.6.7 Short circuit and over voltage protection device shall be provided to protect circuits from faults occurring in all outdoor cables.

7.5.6.8 For further details regarding block wiring refer to provisions in chapter 15.

7.5.7 Outdoor Telephone Cable

7.5.7.1 Polythene Insulated Jelly Filled (PIJF) Telephone Cable per RDSO Specification No. IRS:TC 41-97 with latest amendments shall be used for extending external telephone lines.

7.6 System Expansion

7.6.1.1 The Telephone system shall be expandable to include additional EPABX switches into the central EPABX switch network for telephone communication system without affecting the performance and the operation of the Telephone system. The network management system shall be expandable to control and monitor the additional EPABX switches required for expansion of the network.

7.6.1.2 The EPABX switches shall be expandable to the maximum line capacity by adding extra line cards only with the common control equipment, including the processor unit, memory modules, switching modules, power supply unit, remaining unchanged. However the software license for the full line capacity as per the wired requirement given in this PS shall be provided as part of this Contract.

7.6.1.3 It shall be possible to integrate the PABXs of phase II of WDFC with the telephone system supplied under this contract.

7.6.1.4 With additional plug-in modules/units it shall be possible to expand the Central VRS to cover requirements of WDFC phase II without replacement of the existing hardware and software.

∗ End of Chapter 7 ∗

8 DISPATCH TELEPHONE SYSTEM REQUIREMENTS

8.1 General

8.1.1 The Dispatch Telephone System (DTS) shall provide control telephone communication for train operation, traction power supply control and maintenance telephone lines for track, rolling stock, signalling and telecommunication. The system shall ensure instant, uninterruptible, hot line communication between key strategic points, which shall include, but not be limited to:

(1) between OCC and different key locations like all Station Control Rooms (SCR), ELMD Control Centre (DCC), Traction Sub-station (TSS), Switching Post (SP), Sub Switching Post (SSP), each signalling equipment room, each telecom equipment room and depots and Crew changing rooms etc.
(2) between adjacent/interfacing station control rooms;
(3) between Junction Station/WDFC and Interfacing Station Master Room of IR;
(4) between Junction station control room and Interfacing Junction Station Control Rooms;
(5) between adjacent Junction station control room and DCC;
(6) communication at locations close to the Level cross Gates;
(7) between OCC and DFCCIL HQ;
(8) between OCC/WDFC and OCC/EDFC;
(9) between OCC/WDFC and Emergency services
(10) between OCC/WDFC and IR Sectional Control Centres along the route;
(11) Relevant SCR and OCC/WDFC to 4 points in each IMD and 3 points in each IM Sub Depot.
(12) Relevant SCR and OCC/WDFC to 3 points in residential building at each station.

8.1.2 DTS Console shall have preset buttons such that by pressing one of these buttons shall immediately connect to the destination. On the opposite, when a preset button on the telephone connected to a DTS service is pressed, the corresponding button on the controller's telephone set shall immediately flash together with the ringing tone.

8.1.3 Hot line telephone connections to emergency services shall be extended on leased lines from the telecom equipment rooms closest to their locations. Hot lines to IR control offices shall be extended on lines arranged from IR or leased lines as the case may be.

8.1.4 Hot line telephones to IR stations shall be extended over copper cable/OFC to be provided by the contractor for PABX telephones etc.

8.2 Scope of Works

8.2.1 In addition to what has been stated in chapter 2 the scope of works shall be as given below.

8.2.2 Scope of Supply for the Dispatch Telephone System shall include, but not be limited to the following:

1) Dispatch telephone system switches ;
2) DTS consoles; Refer to Appendix 3 MMI Provision Schedule for supply of Dispatch Telephone Consoles;
3) DTS telephone sets;
4) Software & licenses;
5) power supply equipment, cables and accessories;
6) distribution frames, cabinets, enclosures, racks; and
7) any other materials to complete the scope of work.

8.2.3 Scope of Services

The Contractor shall co-ordinate with Civil Works Contractors on requirements of station building. All the buildings shall be provided with concealed ducts/pipes for wiring of telecom facilities by Civil Works contractors The Contractor shall co-ordinate with the Civil Works Project Contractors to ensure the availability of proper duct/ pipes. Refer to Appendix 9-3 for other interface requirements with Civil Works Contractors

8.3 System Requirements

8.3.1 DTS Console

8.3.1.1 The DTS console for each of the controller positions shall have a minimum direct line capacity of 100 lines and shall be capable of interfacing with required DTS extensions tentatively defined in Appendix 2 “Dispatch Telephone Console Matrix”. The contractor, during the design phase, shall, however, determine the exact size of each of the DTS Consoles and the DTS extensions to be terminated on each Console and submit to the Engineer for review.

8.3.1.2 The DTS console shall be configured as a desktop model/flush mounted in a desk ergonomically matching with the control room furniture.

8.3.1.3 The DTS console shall provide selection facilities in the form of push button and/or soft keys with visual display unit for user to perform, but not be limited to, the following functions as a minimum:

(1) originate outgoing calls to the selected user;
(2) select and answer any incoming calls destined for the DTS console;
(3) originate outgoing calls to a pre-defined group of users;
(4) originate outgoing calls to a group or all users defined by the DTS console at the time before the call is placed;
(5) make conference calls to add additional users to an established call connection;
(6) patch calls or put through two individual users for call connection;
(7) transfer call to EPABX extension; and
(8) make and receive emergency call (override facility).

8.3.1.4 The DTS console shall be equipped with, but not be limited to, the following facilities:

(1) handset;
(2) push button or soft key for each DTS telephone;
(3) 12-push button keypad for dialling;
(4) adjustable volume control for speaker and ringer;
(5) hands-free operation through built-in speaker and microphone;
(6) powered by the Central communications processor;
(7) visual display of details for incoming and outgoing calls;
(8) display of call duration;
(9) system clock display;
(10) lamp for message waiting;
(11) lamp for ringing signal; and
(12) transmit DTMF signal when call has been connected.

8.3.1.5 The DTS communication system shall support a minimum of 8 simultaneous incoming calls to the DTS console to be queued before these calls are answered. The identity of the calling parties in the queue shall be displayed on the DTS console in ascending order of the incoming sequence. Console controller shall be able to answer calls in queue in any sequence. Call answered shall be removed immediately from the display.

8.3.1.6 The selection facilities of the DTS console, in the form of physical push button and/or soft key, shall be labelled with identity of the called party or functions of the selection facilities.

8.3.1.7 The selection facilities shall provide selection status indication in the form of LCD or LED displays.

8.3.1.8 Dedicated push button and/or soft keys shall be assigned to each telephone line which can be connected to the DTS console.

8.3.1.9 At least 10 spare push buttons and/or soft keys shall be provided for assignment of additional functions or telephone lines.

8.3.1.10 The push buttons and/or soft keys of similar functions or nature shall be grouped together to facilitate the user to locate the required selection.

8.3.1.11 The DTS console shall also be provided with functions for operation as an ordinary telephone set. The DTS console shall be equipped with keypad for dialling to originate EPABX telephone call and support on-hook dialling.

8.3.1.12 The DTS console shall give different audio indication for normal and emergency calls.

8.3.2 DTS Telephones

8.3.2.1 DTS telephones or consoles provided in SCR shall have a minimum direct line capacity of 30 lines. DTS telephones provided in the TSS, SPs, SSPs and other remote locations shall have a minimum direct line capacity of 10 lines and shall be capable of interfacing with DTS consoles of Controllers in OCC and the required DTS extensions to be developed during the detailed design phase. The contractor shall however determine the exact size of such DTS telephones and/or consoles during the design phase and submit to the Engineer for review.

8.3.2.2 It shall be possible for the SCR or TSS etc. to make normal and emergency DTS calls to the designated controllers in OCC. Different audio indications for normal and emergency calls shall be provided for incoming DTS calls on the DTS Consoles or DTS telephones.

8.3.2.3 Once the DTS extensions have been programmed on the DTS telephones it shall not be possible for unauthorized change of program from the direct line extensions (DTS telephones

8.3.3 .DTS Telephones at Level Crossing Gates

8.3.3.1 Telephone at level crossing gate shall be connected as a hot line to the dispatch telephone/console of station control room nearest to the level crossing gate or as decided by the Engineer. It shall however be possible to extend the gate telephone to any controller in OCC as well as to any other gate telephone(s) between two stations. Contractor shall submit to the Engineer the proposed system architecture for review. Availability of the gate telephone communication as a minimum shall be 99.995% as for any other DTS telephone connection. Three numbers of level crossing gates are planned as per details given in volume IV Data Book.

8.4 Performance Specification

8.4.1 General

8.4.1.1 In addition to what has been specified in Chapter 3 the following performance requirements for the dispatch telephone system shall be complied:

8.4.1.2 Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

8.4.2 Reliability

8.4.2.1 The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

8.4.2.2 The Contractor shall furnish for the sub-systems/equipment forming dispatch telephone system, the reliability figures, MTBF Hours from the OEMs.

8.4.3 Availability Requirements

8.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the dispatch telephone system shall not be included in the determination of the system availability.

8.4.3.2 The availability of the connection within DTS shall be better than 99.995%.

8.4.3.3 The management system shall be considered unavailable if any functions provided by the management system cannot be properly exercised. The availability of the management system shall be better than 99.95%.

8.4.4 Maintainability Requirements

8.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

8.4.4.2 The service life of the dispatch telephone system (equipment) shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years.

8.4.5 System Safety Requirements

8.4.5.1 The Subsystem shall not present any safety hazard to the operation and maintenance persons.

8.4.5.2 All equipment must comply with, and be installed in conformance with IEC 60065 IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

8.4.5.3 All metallic enclosures shall be provided with an earth terminal and connected to earth.

8.5 Technical Requirements

8.5.1 A digital Voice Recording System (VRS) as specified in Chapter 7 shall record all telephone conversations of all controllers in OCC, ELMD and stations as well as direct line communication between SCR and level crossings.

8.5.2 The DTS switch network shall be synchronized to the master clock signal from the Master Clock System. DTS shall have internal clock in free running mode in the event of the failure or the absence of the Master Clock signal. The slip allowable in the DTS network shall conform to ITU-T Rec.G 822.

8.5.3 Redundancy for important interfaces/modules shall be provided to ensure high system availability with minimum common mode failure allowing graceful degradation.

8.5.4 Network and system shall be resilient to failure providing automatic reconfiguration of equipment with minimum system loss in particular the avoidance of common mode failure of site equipment, optical fibre cable and power supply and software affecting system operation.

8.5.5 Failure of DTS switch at any one location shall not affect the DTS communication between all other switches.

8.5.6 Network architecture shall be future proofed to accommodate in the flexible manner enhancements to equipments and systems with respect to hardware and software upgrades

8.5.7 The Contractor shall set up the priority level for dispatch consoles in consultation with the Engineer.

8.5.8 DTS shall be designed for a Grade of Service (GOS) of 0.1% during an average busy hour under normal conditions.

8.5.9 Network Management System for the DTS shall be provided and the details shall be submitted to the Engineer for review.

8.5.10 OEM's original specifications (data sheets) and other configuration details as a minimum for all equipment forming part of the DTS shall be submitted with the Preliminary/Detailed design submissions for review and consent by the Engineer.

8.5.11 Block Wiring

8.5.11.1 Block Wiring for the DTS telephones shall be as per clause 7.5.6 as applicable.

8.6 System Expansion

8.6.1 DTS shall be expandable for future sections with the facility for providing additional consoles in OCC particularly for Phase II of WDFC and additional stations and DTS extensions without affecting the performance of the Dispatch Telephone System.

∗ End of Chapter 8 ∗

9 MASTER CLOCK SYSTEM REQUIREMENTS

9.1 General

9.1.1 The Clock System shall provide synchronized time information for this Project.

9.1.2 The time source for the Master Clock System shall be obtained from the Global Positioning System (GPS).

9.1.3 The synchronized time information shall be provided to other interfacing systems via the OFC System. Synchronization of the time information of other systems shall be achieved by means of the Network Time Protocol (NTP).

9.1.4 The time source shall be used to synchronize slave clock units which shall be located throughout the WDFC areas such as offices, control rooms, ELMD etc. for staff information.

9.2 Scope of Supply for clock system

9.2.1 The scope of supply shall include, but not be limited to, the following:

(1) GPS receiver and antenna;
(2) Master clock control and distribution equipment;
(3) Sub-master clocks ;
(4) Slave clocks (analogue and digital clock display units) Refer Appendix 4 Clock Schedule;
(5) Power supply cables, earthing and accessories including termination and protection devices;
(6) Installation, Testing and commissioning materials; and
(7) Any other item required to complete the scope of the w**o**rks.

9.2.2 Requirements of Sub-master clock, slave clocks and associated accessories and their installation etc for the ELMD are not in the scope of ST P-5 as these shall be provided by RS P-7 contractor.

9.2.3 Scope of Services

The Contractor shall co-ordinate with Civil Works Contractors on requirements of station building. All the buildings shall be provided with concealed ducts/pipes for wiring of telecom facilities by Civil Works contractors The Contractor shall co-ordinate with the Civil Works Project Contractors to ensure the availability of proper duct/ pipes

9.3 System Requirements

9.3.1 A GPS receiver at OCC shall receive the time source via a rooftop antenna from the satellites of the GPS.

9.3.2 The time source shall be sent to a Central Master Clock Unit which shall convert the time source to synchronization pulses for the use of the slave clock units. The Central Master Clock Unit shall also distribute the time information using NTP by an Ethernet interface to the Data Transmission System.

9.3.3 At stations, ELMD and OCC a Sub Master Clock Unit shall receive the time information from the Data Transmission System and shall convert it into synchronization pulses for the slave clock units at those locations.

9.3.4 Fan Out Units shall be connected to the Central Master Clock Unit and the Sub-Master Clock Units for distributing time information to the slave clock units. Each output port of the fan out unit shall be able to drive a number of slave clock units, and each fan out unit shall have sufficient number of output ports for driving all the slave clock units. Clock Schedule is shown in Appendix 4.

9.3.5 The slave clock units shall be of analogue and/or digital types. The engineering shall ensure that these clock units shall provide good visibility.

9.3.6 Each of the systems that require synchronized time information shall be connected to the OCC or station or ELMD LAN's and obtain the information using the NTP, as the common time source distributed throughout WDFC.

9.4 Performance Specifications

9.4.1 General

9.4.1.1 In addition to what has been specified in Chapter 3, the following performance requirements for the master clock system shall be complied:

9.4.1.2 Fault tolerant design with protections against failure shall be provided in order to achieve the system availability. Protections shall include, but not be limited to path diversity, redundancy and duplication of reliability critical equipment, component and circuits.

9.4.2 Reliability

9.4.2.1 The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

9.4.2.2 Contractor shall furnish to the Engineer the reliability figures i.e. MTBF Hours from the OEMs of the following sub-systems/equipment:

(1) Master clock;
(2) Sub-master clock; and
(3) GPS receiver.

9.4.3 Availability Requirements

9.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Contractor shall submit to the Engineer for review and consent the RAMS analysis for the master clock system to establish the requirements of availability specified herein below.

9.4.3.2 The master clock system shall be considered unavailable if the clock signal is not available at any location or the accuracy of the clock signal is below the specification. The availability of the master clock equipment shall be better than 99.99%.

9.4.4 Maintainability Requirements

9.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Clause 3.4.

9.4.4.2 The service life of the Master clock system shall not be less than 15 years.

9.4.5 System Safety Requirements

9.4.5.1 All equipment must comply with, and be installed in conformance with IEC 60065 IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

9.4.5.2 All metallic enclosures shall be provided with an earth terminal and connected to earth.

9.4.5.3 The free run accuracy of the Master Clock Units shall never be more than 30 milliseconds different from the GPS reference.

9.4.5.4 Network time synchronization over the data network shall be using NTP, with an accuracy of ±0.01 s per 24 hours to the reference.

9.4.5.5 The clock system shall have a minimum accuracy of 1s a day when they do not receive signals from the master clock.

9.5 Technical Requirements

9.5.1 Antenna System

(1) Surge protector shall be provided to shunt potentially damaging voltages on antenna coaxial to ground.
(2) The system shall be weatherproof. It shall be tolerant to direct sunlight, wind, rain and other sources of water.
(3) The antenna shall be mounted at appropriate location to be identified during detail design.

9.5.2 Central Master Clock System

(1) The central system shall consist of a GPS receiver which shall continuously collect the external time information, e.g. Universal coordinated Time (UTC) for date and Indian Standard Time by offsetting as required, with which the system time shall be kept in synchronization.
(2) The master clock shall detect the absence or corruption of the UTC time standard signal and give an alarm if either of these occur. Bad data resulting from a satellite malfunction, temporary reception problems or an erroneous upload to satellite is not used. Errant timing that causes errors in the timing system shall be avoided.
(3) The Central Master Clock shall have its own oscillator and be able to maintain accurate time for normal duration of loss of time synchronization signal. The system shall be able to detect the absence or abnormality of the GPS time signals. The system shall be self-correcting in the event the synchronization from the GPS is lost and re-established.
(4) The system shall support connectivity of Ethernet TCP/IP network, RS485 and RS232.
(5) The system shall include network time server to provide NTP timing for other interfacing systems connected to the OCC, stations or ELMD LAN. The type and quantities of the clock output interfaces shall be determined by the interface requirements of the subsystems and relevant interfacing project contractors.
(6) Outages of power supply of normal duration to the system shall have no significant impact on the accuracy of the system time.
(7) Audio and visual alarm outputs shall be provided to indicate loss of time synchronization or power.
(8) The status of the Master Clock system equipment including GPS receiving system, master clock, clock distribution system, sub master clocks and the NTP servers shall be monitored by the OFC communication NMS or a dedicated management system.

9.5.3 Sub Master Clock

(1) The station/ELMD sub-master clock shall be provided in (1+1) configuration and synchronized by the central master clock.
(2) The station/ELMD sub master clock shall have its own internal clock and be able to maintain accurate time for normal duration of loss of time synchronization signal. The system shall be able to detect the absence or abnormality of the synchronized time signal from the central master clock system. On restoration of the Master Clock signal the sub master clock shall validate the signal and after successful validation the sub master clock shall self-correct if necessary.
(3) Local display of the time shall be provided. Display shall include hours and minutes.

9.5.4 Display Clocks

(1) All display clocks shall be synchronized by the central/station/ELMD sub master clocks.
(2) The displayed time of all display clocks shall be to the minute.
(3) Analog slave clocks for indoor use shall be of a minimum diameter of 30cm.
(4) Digital slave clocks for indoor use shall be 7 segments LED type with minimum digit height 57mm.
(5) The analog and digital display clocks shall be visible from a minimum distance of 30m and 20m respectively.
(6) The display shall be clear under relevant, frequently occurring lighting conditions, including direct sunlight (from behind and in front) and when there are any reflections in the clock faces.
(7) The optical characteristics of the transparent display cover shall be selected such that the light transmission and display contrast are suitable for the environment in which the clocks are installed.
(8) Subject to the architectural constraints for each specific location, the clocks shall either be wall mounted or ceiling mounted or pole mounted. The contractor shall determine the mounting method and submit to the Engineer for review and approval before installation.

9.5.5 The Master Clock system shall be capable of working from 230 volts +/- 20% AC 50 Hz supply from the Power Supply System (PSS) common for signalling and telecommunication systems.

9.5.6 OEM's original specifications (data sheets) and other configuration details as a minimum for all equipment forming part of the Master Clock System shall be submitted with the Preliminary/Detailed design submissions for review and consent by the Engineer:

9.6 System Expansion

9.6.1 The Master Clock system shall be equipped with capacity to provide clock signal and timing reference distribution to a minimum of 25 additional stations.

9.6.2 The system shall be able to support the required number of display clocks plus a minimum 10 additional clocks at each location.

∗ End of Chapter 9 ∗

10 VIDEO SURVEILLANCE SYSTEM REQUIREMENTS

10.1 General

10.1.1 The Video Surveillance system shall provide effective real time video surveillance of OCC building complex as well as create temper proof video recording for post event analysis. OCC is located at Ahmedabad.

10.1.2 Video surveillance system shall be end to end IP Based with fixed IP cameras, P/T/Z IP dome cameras, recording servers and PCs to view on LCD monitors

10.1.3 Each camera shall have a video at 4 CIF (Common Intermediate Format) and 25 frames and a dual stream capability such that viewing and recording at different resolutions and frames per second are possible.

10.1.4 Video surveillance system and cameras shall offer dual streams of H.264 video compression standards at 4 CIF and 25 frames simultaneously.

10.1.5 The storage device for recording shall be external with RAID 5 protection.

10.1.6 The system shall provide on-line display of video images on LCD monitors located in the security control room in OCC complex

10.2 Scope of the Works

10.2.1 Scope of Supply for Closed Circuit Television System

10.2.1.1 The scope of supply for the IP based CCTV system shall include, but not be limited to, the following:

(1) high resolution fixed box type Colour I P camera, with vari focal lens complete with housing and mount;
(2) High resolution fixed dome type IP colour camera;
(3) P/T/Z dome IP colour camera (day / night);
(4) CCTV MMI consisting of at least one 40” LCD colour Monitors for monitoring on large screen;
(5) Digital Key Board for PTZ functionality;

;

(6) client PC workstation with 20” LCD monitor for viewing, monitoring & system management;
(7) Server hardware for video management and recording;
(8) External storage device with RAID -5;
(9) Layer-2 field switch and Layer-3 Switch;
(10) Video management and video recording software and perpetual licenses;
(11) Graphic User Interface Client Software;
(12) equipment cabinet, racks and cubicles;
(13) power and data cables, power supplies, cabling and earthing accessories including termination protection devices; and
(14) any other equipments/materials/software as required for completion of the contract.

10.2.2 Scope of Services

10.2.2.1 In addition to what has been listed in chapter 2 the Contractor shall co-ordinate with Civil Works Project Contractors on location of cameras.

10.3 System Requirements

10.3.1 General

10.3.1.1 The CCTV system shall have facilities for colour monitoring in real time.

10.3.1.2 CCTV control equipment shall be installed in the CER of OCC.

10.3.2 CCTV Coverage

10.3.2.1 The video cameras shall be strategically placed to ensure 100% coverage of all entrances, exits, protection of boundary wall of OCC complex, all lift lobbies at all floors, office reception area, entrance to OCC theatre(s), plant & equipment rooms etc.

10.3.2.2 The viewing of images shall be at 25 fps 4 CIF (Common Intermediate Format) while Recording/storage shall be provided at 2CIF/4CIF.

10.3.3 MMI for OCC security controllers shall consist of one number of LCD monitor of minimum 40" and Key Board with Joystick controllers and Mouse-Keyboard controller

10.3.4 Display Requirements

10.3.4.1 The general guideline for displaying the full frame image height of a 1.8m tall person standing upright, within the CCTV camera coverage area, on any monitor shall not be less than one tenth of the screen for both fixed lens and zoom lens cameras at the shortest focal length. No image degradation shall be caused on the CCTV monitors owing to any external sources of interference including, distortion of the image at the periphery of the screen, rotation of image, mis-convergence of colour image and changes of colours on the screen due to changing of external magnetic field level.

10.3.5 Video Recording and Retrieving

10.3.5.1 The video recorder shall be capable of operation for 24 hours per day, 365 days a year. The recording shall be preferably stored for at least 30 days at 2 CIF, 25 frames per second. System should, however, be capable of recording at 4 CIF 25 frames per second for all cameras.

10.3.5.2 It shall be possible for the Security controller in the OCC to simultaneously retrieve recorded images. All recordings shall have the associated time and date stamped information superimposed onto the video image.

10.3.5.3 In the event of recording operation being interrupted, for example by power failure, it shall automatically resume recording, on resumption of power supply, of all the cameras it was recording prior to the interruption.

10.4 Performance Specifications

10.4.1 General

10.4.1.1 In addition to what has been specified in Chapter 3 the following performance requirements for the CCTV system shall be complied:

10.4.2 Reliability Requirements

10.4.2.1 The Contractor shall furnish for the following sub-systems/equipment, the reliability figures, MTBF Hours from the OEMs:

(1) control and management equipment
(2) Fixed Cameras/PTZ cameras
(3) Monitors
(4) Video recording equipment
(5) Digital CCTV Keyboard
(6) Other equipment used in the system

10.4.3 Availability Requirements

10.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the CCTV system shall not be included in the determination of the system availability.

10.4.3.2 The conditions which shall be considered as failures shall include, but not be limited to:

(1) failure of any CCTV MMI in OCC;
(2) failure of any switch or CCTV system control equipment;
(3) all failure conditions leading to the loss of CCTV video signal for more than 10% of CCTV cameras.

10.4.3.3 The CCTV system shall have an overall availability of better than 99.99%.

10.4.4 Maintainability Requirements

10.4.4.1 The Contractor shall comply with the maintainability requirements as specified in Chapter 3.

10.4.5 System Safety Requirements

10.4.5.1 All equipment must comply with and be installed in conformance with IEC 60065 IEC 60364 or equivalent National Electric Code/Uniform Building Code of safety standards.

10.4.5.2 All metallic enclosures shall be provided with an earth terminal and connected to earth.

10.4.6 Service life of the CCTV system shall be at least 15 years.

10.5 Technical requirements

10.5.1 General

10.5.1.1 Manufactured products shall have quality system compliance and shall be UL or EN and FCC certified.

10.5.1.2 Proposed CCTV system shall be based on Non Proprietary open standard architecture affording interoperability of hardware, software, OS, networking etc.

10.5.1.3 All control equipments e.g. servers, storage devices etc shall be Rack mounted.

10.5.1.4 No equipment other than cameras, field switches, cables and their junction boxes shall be installed outside the CER.

10.5.1.5 Failure of one camera shall not affect other cameras.

10.5.1.6 Field maintenance shall be possible with laptop preloaded with complete CCTV system software.

10.5.1.7 All servers in the OCC shall be provided with back up.

10.5.1.8 The internal clock for the CCTV system equipment shall be synchronised to within 1 second of the Master Clock system at all times.

10.5.1.9 All equipment of CCTV system shall work from 230 V +/- 20% 50 Hz AC single phase supply from Power Supply System (PSS) common for Signalling and telecomm.. Appropriate AC supply distribution cubicles/racks complying to IP54 with 20% spare

capacity shall be provided for this. Equipment shall be capable of withstanding ripple of 2%.

10.5.1.10 System shall comply with the EMI/EMC requirements.

10.5.2 Hardware Requirements for the video surveillance system, as listed below shall be as specified in RDSO specification NO. RDSO/SPN/TC/65/2009 (Revision 1) or latest

10.5.2.1 High Resolution Fixed IP colour camera, day / night.

10.5.2.2 Varifocal Lenses of IR corrected 7. 5 mm to 50 mm used for fixed box type camera.

10.5.2.3 Housing Arrangement for Fixed box type IP camera for both outdoor and indoor use.

10.5.2.4 Mount for the Camera.

10.5.2.5 High resolution Fixed Dome Type IP colour Camera suitable for indoor /outdoor surveillance.

10.5.2.6 High Speed P/T/Z IP Colour Camera (Day/Night).

10.5.2.7 High resolution large video display unit 102cm (40”) for MMI of security controller.

10.5.2.8 Colour display LCD monitor with 20” for Client Workstation.

10.5.2.9 Digital Keyboard.

10.5.2.10 PC Workstation for Viewing, Monitoring and System Management.

10.5.2.11 Server Hardware for Network Video Management and Recording.

10.5.2.12 External Storage Device With RAID 5 HDD Storage.

10.5.2.13 Layer 2 Switches (8 port) for Field.

10.5.2.14 Layer 3 Switch for Control Room.

10.5.2.15 Cable types of STP CAT-6 Cable, RG-11 Video cable, Twisted Pair Cable with Shielding, Power Cable and Optic Fiber Cable.

10.5.2.16 Accessories for Terminating Optic Fiber Cables like Fiber Optic Interconnect Unit (FOIU), Optic Fiber Connectors, Optic Fiber Adaptors and Optic Fiber Patch Cords.

10.5.2.17 Copper to Fiber Media Convertor as required.

10.5.3 Software for following Requirements shall be as specified in RDSO specification NO. RDSO/SPN/TC/65/2009 (Revision 1) or latest:

10.5.3.1 Network Video Management Software

10.5.3.2 Network Video Recording Software

10.5.3.3 Video Analytics Software for implementing Intrusion Detection for boundary wall of the OCC building complex

10.5.3.4 GUI (Graphic User Interface) Client Software Features

10.5.3.5 Licensing for all software shall be forever and shall be as specified in RDSO specification NO. RDSO/SPN/TC/65/2009 (Revision 1.0) or latest

10.5.4 OEM's original specifications (data sheets) and other configuration details as a minimum for all equipment forming part of the proposed system shall be submitted with the Preliminary/Detailed design submissions for review and consent by the Engineer:

10.6 System Expansion

10.6.1 CCTV equipment shall as a minimum be modularly expandable to an expansion capacity of 50% by the addition of cards and/or modules without the need to replace the installed hardware and software of the system.

∗ End of Chapter 10∗

11 48 V DC BATTERY BACKUP SYSTEM REQUIREMENTS

11.1 General

11.1.1 The Battery Backup system for each TER and CER, with redundant configuration, shall be sized to power its full load including (but not limited to) radio system, telephone system (EPABX and Dispatch telephone system) and OFC communication system.

11.1.2 Battery backup system shall also be provided at each of the GSM-R base station locations other than at stations and OCC.

11.1.3 Contractors CT P-1, CT P-2 and CT P-3 shall provide 3 phase/1 phase AC power supply source for battery backup system at each of the stations in their jurisdiction. Further distribution shall be the responsibility of ST P-5.

11.1.4 At porta huts EM P-4 shall provide 1 phase AC power supply from UP & Down catenaries with an automatic change over switch. Automatic change over switch shall be provided by EM P-4 inside telecom porta huts. Further distribution shall be the responsibility of ST P-5.

11.1.5 The Battery shall consist of VRLA (maintenance free) cells.

11.1.6 The battery chargers shall be of SMPS type.

11.2 Battery Back Up System Design Requirements

11.2.1 The battery backup equipment shall conform to RDSO and/or TEC specifications and other international standards as applicable.

11.2.2 Design shall take into consideration the voltage drop between the power supply source and the Telecommunication system load individually at each location (station, OCC, porta huts etc.)

11.2.3 Provision of suitable earth leakage detection and alarms shall be made individually at each location (station/porta hut locations, OCC, etc.)

11.2.4 Provision shall be made for surge protection, earthing, shielding etc. of the power plant to avoid possible interference to the operation of the telecom equipment...

11.3 Technical Requirements

11.3.1 For high availability the Battery Backup system at each location shall include 2 numbers of SMPS based 48 V Battery Chargers in on-line redundant configuration with individual 48 V battery banks for each battery charger.

11.3.2 Each of the two Battery banks shall provide busy hour reserve of a minimum of four hours for all equipment installed in telecommunication equipment rooms at stations, porta huts and at OCC etc.

11.3.3 The transformers insulation class shall be in accordance with heat they are likely to generate but in no case the insulation class shall be worse than class B insulation.

11.3.4 For sizing the battery capacity the peak power requirement of all equipments to be installed in each equipment room shall be considered. Battery capacity at each location shall be determined as per IEEE 485 and relevant factors like K factor as applicable, ageing factor (1.25), Design Margin (1.1), temperature factor and ECV as

applicable for the type of battery and usage shall be considered. In addition spare capacity of 25% shall be provided to cater for any future requirement of additional equipment at that location. Battery capacity calculations shall be submitted to the Engineer for review.

11.3.5 Battery charger capacity shall be determined as a minimum as load current + battery capacity*10%. Additional 25% spare capacity shall also be provided for expansion and future requirements. Contractor shall submit calculations, to the Engineer for review, for sizing the battery and battery chargers at each location.

11.3.6 An additional battery set consisting of a six cell block each of the same voltage as in the two main 48 V battery banks shall be provided at each station. This set shall be maintained on charge from the charging unit such that one or more cells from this set can replace the faulty cell (s) / cell block of the working battery banks. The spare cell charger shall be suitable to charge the type of VRLA batteries being used.

11.3.7 Battery Chargers (except spare cell charger) shall be of SMPS type and meet RDSO specifications RDSO/SPN/TC/23/99 version 4.0 with latest amendments. Each charger system shall be sized to power full load of OFC communication system, radio system, telephone system etc and simultaneously charge the fully discharged battery bank connected to it at 10 hour rate of charge for the battery. Battery chargers shall be procured from RDSO approved sources only and shall be got inspected by RDSO. All co-ordination and all inspection related charges shall be the responsibility of the Contractor.

11.3.8 The service life of the SMPS based battery chargers shall not be less than 15 years.

11.3.9 The service life of the VRLA battery cells shall not be less than 10 years.

11.3.10 The Battery Backup shall include line protecting devices, chargers, battery banks and changeover logic system for change over from battery set 1 to battery set 2 and vice versa and load distribution.

11.3.11 There shall be no break in the battery supply to the Telecommunication systems during changeover from the working to standby battery set or during maintenance

11.3.12 The design shall ensure that the failure of a single component does not cause failure of the Backup system.

11.3.13 The charger shall be of the self-contained floor- mountable, top or bottom entry determined during design, metal-clad type with front access.

11.3.14 All batteries for installation in the WDFC shall be of the Sealed Maintenance Free, Valve Regulated, Lead Acid (VRLA) type to RDSO specifications IRS S93 – 96 with latest amendments for battery capacities up to and including 500 AH and to DOT specifications No. TQ 510G 92 with latest amendments for capacities above 500AH. VRLA Battery cells to RDSO Specifications shall be procured from RDSO approved source only and to DOT Specifications shall be procured from DOT approved sources only.

11.3.15 The following data shall apply to 48 V DC battery backup system:

(1)	Input voltage range (Three or single phase)	: 415V AC (+10 %, - 20%) or 230 Volt (+10%, -20%)
(2)	Input frequency	: 50 Hz +/-5%

(3) Output Current : As required for each location

11.3.16 Battery Backup system functions shall include:

(1) Low voltage battery disconnection (LVD)
(2) Battery disconnection pre-alarm
(3) Battery current limiting
(4) Temperature compensated charging
(5) Test mode facility

11.3.17 System control functions shall include:

(1) Float/ charge mode facility
(2) Auto/Manual Switch for boost charging

11.3.18 System Protection shall include

(1) High voltage input disconnection (HVD)
(2) Lightning protection/Surge protection
(3) Transient absorbers for component protection
(4) Load fuses/MCB's as required
(5) Battery fuses /MCB's as required

11.3.19 Alarms for the battery backup system shall be implemented locally on the front panels of SMPSs and remotely through OFC communication NMS in the CER at OCC using appropriate interface such as RS-232 TCP/IP etc. Following alarms shall be provided on the NMS of OFC at OCC for each of the two SMPS/Battery Banks at all locations:

(1) Mains fail
(2) Operation OK
(3) Input voltage high
(4) Over load
(5) Boost mode
(6) Float mode
(7) Rectifier Modules fail (one or more than one)
(8) Mains low
(9) Battery cut-off pre-alarm
(10) Over temperature
(11) Summary Alarm

11.3.20 In case a dedicated NMS is provided for the battery backup system, the same shall be implemented with 21" TFT Based MMI kept in the CER at OCC.

11.4 System Expansion

11.4.1 The Battery Backup system shall be designed and equipped with all necessary hardware, software and capacity for future 25 % additional load. All the components like Transformers, Batteries, etc. shall as a minimum cater to 25% spare capacity.

∗ End of Chapter 11 ∗

12 INTERFACES

12.1 Interfaces between Subsystems

12.1.1 The details of interfacing between Subsystems shall be as described in Chapters 5 to 11 of this Particular Specification and here below.

12.1.2 The Contractor shall provide the description of the interfacing between Subsystems with sufficient details so as to enable the Engineer to modify or expand the interfaces between the Subsystems.

12.2 Interfaces with Project Contractors

12.2.1 Interfaces with other Project Contractors are described in Appendices 8 & 9 (9-1, 9-2, 9-3, 9-4 and 9-5)

13 VERIFICATION, TESTING AND COMMISSIONING

13.1 General Guidelines for Testing and Commissioning

13.1.1 The Contractor shall perform stage-wise testing and commissioning activities in accordance with the requirements given in this Specification.

13.1.2 The Contractor shall ensure that the Engineer prior to the commencement of the test has reviewed test documentation associated with any test without objection.

13.1.3 The Contractor shall ensure the System is in a state ready for testing and commissioning before the commencement of the tests witnessed by the Engineer. The Contractor may conduct trial tests by himself before the Engineer witnesses the tests, if necessary.

13.1.4 Test results of the Contractor's own trial tests shall be made available to the Engineer on request before the tests are witnessed by the Engineer, to indicate the readiness of the System for tests witnessed by the Engineer to commence.

13.1.5 The Contractor shall satisfy himself that all items interfacing to Project Contractors are in satisfactory condition for the Contractor's tests to be carried out.

13.1.6 The Contractor shall provide all necessary test instruments, special tools, emulators, simulators and test software to carry out the tests.

13.1.7 The Contractor shall provide simulation for testing in case the interfacing equipment is not available for testing.

13.1.8 The Contractor shall extend full support to the Engineer and provide all necessary facilities to enable convenient inspection of materials, work and testing.

13.1.9 The Contractor shall investigate and provide corrective actions for all the faults detected during the tests. The tests shall be resumed only after all the faults are properly cleared. The Contractor shall submit fault report to the Engineer to describe the symptom and causes of the faults and the corrective actions taken.

13.1.10 If the operation of other project contractor's system or equipment is suspected to be affected by the system during the test, the contractor shall withhold the test, investigate and provide corrective actions, if necessary, before resumption. The test shall be resumed only after the interference has been eliminated or found not to be related to the system.

13.2 Testing Stages

13.2.1 The Contractor shall carry out testing and commissioning activities in the following phases:

(1) Factory Acceptance Tests;
(2) Installation Tests;
(3) Partial Acceptance Tests;
(4) System Acceptance Tests; and
(5) Integrated Testing and Commissioning.

13.3 Factory Acceptance Tests

13.3.1 The Contractor shall carry out factory acceptance tests at the place of manufacturing in the presence of the Engineer. The test shall include, but not be limited to, visual, environmental, electrical and functional tests on each individual equipment and

associated Subsystem as well as simulation before delivery of the equipment to the Site.

13.3.2 Factory acceptance test shall be carried out for equipment and cables of all the Subsystems.

13.3.3 The Contractor shall prepare and submit a Factory Test Plan at least six months before the tests. In addition, the Factory Test Plan shall also include the following:

(1) a list of equipment and cables for individual Subsystem to have factory acceptance test;
(2) the program of all the activities related to factory acceptance tests;
(3) the locations where factory acceptance tests to be carried out;
(4) the estimated duration of tests activities at each locations; and
(5) submission schedule of all the factory acceptance test procedures for equipment and cable.

13.3.4 The Contractor shall prepare the factory acceptance test procedures for equipment and cables and submit to the Engineer for review.

13.3.5 The factory acceptance test procedures shall describe in detail all tests to demonstrate the functional, electrical and physical performance of the equipment and cable under designed environmental conditions.

13.3.6 Where any part of testing is carried out by an independent laboratory, a copy of Test Certificate issued by the relevant authority of that laboratory shall be submitted along with the Acceptance Test Procedure.

13.3.7 Factory acceptance tests for Equipments procured to RDSO or TEC specifications and procured from RDSO/TEC approved sources shall be got done from RDSO or TEC as applicable.

13.4 On-site Testing and Commissioning

13.4.1 General

13.4.1.1 The Contractor shall prepare and submit to the Engineer for review an On-site Testing and Commissioning Plan.

13.4.2 Installation Tests

13.4.2.1 Installation Tests shall be carried out on individual Subsystem location by location after the completion of equipment physical installation.

13.4.2.2 The objective of the installation tests shall be to ensure the following:

1) the equipment is installed in accordance with the reviewed Design documentation
2) the equipment is installed in accordance with the requirements detailed in this Specification
3) all cables are properly and accurately connected and terminated
4) all installation works are of acceptable workmanship

13.4.2.3 The Contractor shall develop procedures for Installation Tests and submit to the Engineer for review.

13.4.2.4 The Installation Test shall not be started unless the test procedures have been reviewed without objection by the Engineer.

13.4.2.5 All installed equipment and cables shall be physically inspected against all relevant review Design documentation.

13.4.2.6 The Contractor shall measure the end-to-end performance of all cores of the copper cables and optical fiber cables, including all spare cores, laid between different locations.

13.4.2.7 The Contractor shall verify all the connections within the antenna network and measure the attenuation and VSWR values of all the connections.

13.4.2.8 All the installation test results, physical locations of the equipment and serial numbers shall be captured in the test record forms. The Contractor shall include completed test record forms in the Test Report and submit to the Engineer for review.

13.4.3 Partial Acceptance Tests

13.4.3.1 Partial Acceptance Tests shall be carried out on individual Subsystem location by location, on areas or Section basis to verify the functions, performance and services coverage at the stage:

(1) after successful completion of the Installation Tests;
(2) after the Subsystems have been configured with correct settings and parameters;
(3) properly connected to the power supply and can be switched on for Partial Acceptance Tests; and
(4) before the equipment of different locations are connected up and ready for System Acceptance Tests.

13.4.3.2 The Contractor shall develop Partial Acceptance Tests procedures for each Subsystem and submit to the Engineer for review.

13.4.3.3 The Partial Acceptance Tests procedures shall include:

(1) objectives of the Partial Acceptance Tests for all Subsystems;
(2) list of specifications and standards, reviewed Design documentation for reference;
(3) step-by-step test instructions;
(4) list of test instrument and special tools;
(5) test record forms; and
(6) pass or fail criteria.

13.4.3.4 Where performance across interfaces to Project Contractors or to other parties is required to be verified during the Partial Acceptance Tests, the Contractor shall include a list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the Partial Acceptance Tests procedures for the relevant Subsystem.

13.4.3.5 The functional, electrical and timing performances of the Subsystems shall be verified against the requirements and relevant international standards.

13.4.3.6 All local alarms, control and monitoring functions shall be verified.

13.4.3.7 All equipment settings and parameters shall be verified and recorded in the reviewed test record forms.

13.4.3.8 Coverage test shall be carried out on location basis for the Radio system.

13.4.3.9 The Contractor shall perform functional check and signal strength measurement on the radio system for each channel at spots reviewed by the Engineer to verify the radio signal coverage requirements given in Chapter 4.

13.4.3.10 The Contractor shall conduct continuous signal strength following the pre-determined paths given by the Engineer with the frequency of the radio system. The Contractor shall submit graphs of the signal strength measurement as part of the Partial Acceptance Test Results of the radio system.

13.4.3.11 The Partial Acceptance Tests are considered completed only if the Engineer without objection reviews the Partial Acceptance Test results.

13.4.3.12 Upon completion of the Partial Acceptance Test, the individual Subsystem shall be operational and ready to be connected to other Subsystems and interfacing systems for testing.

13.4.4 System Acceptance Tests

13.4.4.1 System Acceptance Tests shall be carried out to ensure the System operates in accordance with functional and electrical performance requirements given in the Particular Specification.

13.4.4.2 System Acceptance Tests shall be carried out at the following stages:

(1) after completion of Partial Acceptance Tests for each Subsystems; and

(2) after all individual Subsystems have been connected together and the System as a whole is capable to operate in all respect in accordance with the requirements given in the Particular Specification.

13.4.4.3 The Contractor shall submit a System Acceptance Tests Plan to the Engineer for review.

13.4.4.4 The Contractor shall conduct end-to-end circuit test to verify the circuit integrity and electrical performance for all circuits including spare.

13.4.4.5 All alarm points shall be verified with simulated faults.

13.4.4.6 All protection mechanisms such as hot-standby, parallel redundancy, automatic switchover, etc, built into the System and individual Subsystem shall be verified.

13.4.4.7 The system response time of relevant Subsystems and the System shall be tested and measured.

13.4.4.8 The Contractor shall carry out load test on each Subsystem to verify the designed system capacity and performance in accordance with the requirements given in the Particular Specification under full load condition.

13.4.4.9 The Contractor shall carry out tests on the operation of the System in accordance with the normal operation procedures and emergency operation procedures, which has been reviewed without objection by the Engineer.

13.4.4.10 The Contractor shall carry out tests on the OCC operation of the System in accordance with the reviewed operation procedures as below:

(1) when OCC is the master control; and

(2) switchover from main to standby control within OCC, if applicable.

13.4.4.11 Where performance across interfaces to Project Contractors or to other parties is required to be verified during the System Acceptance Tests, the Contractor shall include the list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the System Acceptance Tests procedures for the relevant Subsystem or Subsystems.

13.4.4.12 The System Acceptance Tests are considered completed only if the System Acceptance Tests results are reviewed by the Engineer without objection.

13.4.4.13 Upon completion of the System Acceptance Tests, the System shall operate in accordance with the functional and electrical performance requirements given in the PS.

13.4.5 Integrated Testing and Commissioning

13.4.5.1 The Contractor shall carry out Integrated Testing and Commissioning after the completion of the System Acceptance Tests.

13.4.5.2 The Contractor shall co-ordinate with the Engineer and with all the interfacing Project Contractors to ensure all the interface test activities are completed in accordance with the program on Completion Plan.

13.4.5.3 The Contractor shall provide all necessary supports, conduct investigation and provide corrective actions, if necessary, to ensure all matters related to interfacing are properly resolved.

13.4.5.4 Within one week upon completion of all interface test activities, the Contractor shall submit the test results to the Engineer for review.

13.4.5.5 After the test results of all interface test activities have been reviewed by the Engineer without objection, the Contractor shall start the reliability demonstration test in accordance with the reviewed reliability demonstration test plan.

13.4.5.6 The Contractor shall advise the Engineer in writing the commencement date of the reliability demonstration test.

13.4.5.7 The Contractor shall submit a reliability demonstration test plan to the Engineer for review at least three months before the test.

13.4.5.8 The reliability demonstration test shall be done for a minimum period of three months. The Contractor shall include the following in the reliability demonstration test plan as a minimum:

(1) calculation of the maximum allowable number of failures of equipment, Subsystems and System during the reliability demonstration period in accordance with requirements on reliability performance of the equipment, Subsystems and System given in the Particular Specification
(2) definition of relevant failures
(3) pass and fail criteria
(4) sample of fault logs

13.4.5.9 During the reliability demonstration test period, the Contractor shall record details of all faults in a fault log which shall include:

(1) the date and time the fault occurs
(2) the date and time the Contractor's staff arrive on site
(3) the date and time the fault is cleared and the normal operation is restored
(4) the description of the fault

(5) the cause of the fault
(6) equipment or component replaced

13.4.5.10 All fault logs shall be submitted to the Engineer for review.

13.4.5.11 The reliability demonstration test is considered a failure if:
(1) the actual number of relevant failures exceeds the maximum allowable number of failures for any equipment, Subsystems or System identified in the reliability demonstration test plan
(2) any fault resulting from the Design omission or commission of error requires Design modification in order to fix the fault

13.4.5.12 If the reliability demonstration test fails, the Contractor shall provide all the necessary corrective actions and rectify the fault to the satisfaction of the Engineer.

13.4.5.13 The reliability demonstration test shall be repeated on the affected Subsystem or Subsystems for another three months until the test is successfully completed.

13.4.5.14 Within two weeks upon completion of the reliability demonstration test, the Contractor shall submit the test results for the Engineer to review.

13.4.5.15 The Integrated Testing and Commissioning is considered completed only if all the test results of the Integrated Testing and Commissioning have been reviewed by the Engineer without objection.

13.4.6 Trial Runs

13.4.6.1 The Contractor shall provide all necessary support and attendance to the Engineer during the Trial Run period in accordance with the requirements given in General Specification.

13.4.6.2 The Contractor shall provide on-Site supports to the Engineer in all aspects related to the operation of the System. The Contractor shall also conduct investigation and provide corrective actions for any problems related to the System or the interfaces with the System.

13.4.6.3 The Contractor shall assign competent staff to support the Trial Runs as required by the Engineer. The persons shall be the engineering staff who shall have sufficient skills and knowledge of the System and shall have been involved in the Design, installation or commissioning of the System.

13.4.6.4 The Contractor shall submit a manpower plan to the Engineer for review at least 1 month before the commencement of the Trial Runs.

13.4.6.5 The manpower plan shall include the organisation chart of the Contractor's Trial Run supporting group, individual person's role and responsibility and 24-hour contacts for emergency cases.

∗ End of Chapter 13 ∗

14 PACKAGING, SHIPPING, STORAGE AND DELIVERY

14.1 Packaging

14.1.1 General

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

14.1.2 Cable Drums

14.1.2.1 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.

14.1.2.2 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.

14.1.2.3 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.

14.1.2.4 Cables shall be supplied on drums in the longest possible lengths and within practical limits.

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

14.1.2.6 The drums shall also be designed for use in conjunction with any special cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

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

14.1.2.8 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.

14.2 Storage

14.2.1 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.

14.2.2 The Contractor shall maintain records of stored items for this Contract and make available for the Engineer for inspection upon request.

14.3 Delivery

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

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

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

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

14.3.5 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.

14.3.6 No dangerous goods shall be delivered to the Site.

∗ End of Chapter 14 ∗

15 INSTALLATION

15.1 General

15.1.1 The Contractor shall supervise all installation of the Works and shall ensure that all technical, safety and quality matters are adhered to the Design reviewed by the Engineer.

15.1.2 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.

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

15.1.4 The Contractor shall ensure his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

15.1.5 The Contractor shall carry out site surveys to ensure sufficient knowledge on the Site before submitting the relevant installation drawings and installation related submissions to the Engineer for review.

15.1.6 The Contractor shall submit calculation, if required by the Engineer, to demonstrate the proposed brackets and mounting methods are sufficient to withstand the wind loading for the equipment.

15.1.7 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.

15.1.8 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.

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

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

15.1.11 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.

15.2 Installation Programme

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

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

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

(1) Installation schedule;
(2) Coordination Events and Key Milestones;

(3) site access; and
(4) interfacing with relevant Project Contractors.

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

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

15.2.6 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 to the Engineer's attention.

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

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

15.3 Installation Works

15.3.1 Installation in Equipment Rooms

15.3.1.1 The following equipment rooms will be provided by Civil Works Project Contractors to install the telecommunication equipment:
(1) Telecommunication Equipment Room at stations, Central Equipment Room at OCC.
(2) Telecom Power Supply Room at stations and OCC.

15.3.1.2 ST P-5 contractor shall provide Porta huts for telecom equipment and the power supply equipment rooms at all other locations other than stations and OCC.

15.3.1.3 Electric power to the equipment room shall be drawn from the nearest power supply switch which will be provided by other project contractor for the telecommunication equipment.

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

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

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

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

15.3.1.8 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.

15.3.1.9 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.

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

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

15.3.2 Installation Around Station Areas

15.3.2.1 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.

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

15.3.2.3 The equipment, mounting brackets, cables and accessories shall be made of materials which are resistant to ultra violet rays.

15.3.2.4 All trackside equipment and the mounting method shall be designed in the way to minimise the frequency of preventive maintenance.

15.3.3 Installation of Cab Radio Equipment

15.3.3.1 Cab radio equipment including antenna shall be installed in each of the Electric Locomotives. The radio including trans-receivers, cabling, connectors and terminal strips, antenna system, power supply units and train radio MMI etc. shall be manufactured, supplied by the ST P-5 Contractor and installed by RS P-7 contractor at locomotive manufacturers work shop as defined in appendix 9-2. Following equipment as a minimum shall be supplied and installed in the leading and trailing cabs of the electric locomotive:

Item	**Unit**
Roof mounted Train Radio Antenna and associated RF connectors and cables etc.	1 set
Train Radio Driver Control Panel + hand set with PTT switch & cradle + loudspeaker etc.	2 sets
Train Radio Transceiver + Interface Unit etc.	1 set
Connecting RF and power cabling etc.	As required
Any other equipment required to complete the cab radio installation.	As required

15.3.3.2 The mounting of the radio and its sub-assemblies shall be designed to facilitate ease of maintenance.

15.3.3.3 The train radio MMI shall be positioned and fixed to make it splash proof.

15.3.3.4 All cabling and terminations shall adopt standard wiring practice.

15.3.3.5 Cab radio installation shall be rugged and capable of withstanding vibrations expected in such type of Electric Locomotives. Information on expected level of vibration may be obtained from Contractor of RS P-7 contract package for Procurement-cum-maintenance of Electric Locomotives.

15.3.3.6 The Contractor shall submit the following to the Engineer for review at least 3 months before the commencement of radio installation in the Cabs:

(1) drawing showing equipment layout, racks, cabinets and enclosures;
(2) racks, cabinets layout drawings showing the arrangements of individual modules;
(3) schematic diagrams and wiring diagrams of the system;
(4) electric power requirements, wiring and earthing arrangements; and
(5) inter cab (front and rear cabs of the same Electric Locomotive) cabling requirements.

15.3.3.7 Installation works in the leading and trailing cabs of the electric locomotive and inter cab wiring shall be carried out after the submissions have been reviewed without objection by the Engineer.

15.4 Cabling

15.4.1 Primary cable containment around station areas will be provided by Civil Works Project Contractors. For this all the buildings shall be provided with concealed ducts/pipes for wiring of telecom facilities by Civil Works contractors The Contractor shall co-ordinate with the Civil Works Project Contractors to ensure the availability of proper duct/ pipes.

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

15.4.3 The Contractor shall provide rugged "permanently solid lubricated" minimum 40 (or more) mm HDPE telecom duct as per TEC specifications along with the accessories and the facility of' "air blowing" armoured Optical fiber Cable (s). All optical fiber cables shall be laid through "permanently solid lubricated" HDPE telecom ducts suitable for armoured cables. The Contractor shall submit the working drawings with the following details to the Engineer for review at least three months before the cabling activities:

(1) cable routes;
(2) details of the cables to be laid along the proposed cable routes including cable types, number of cables, cable diameter, core count and estimated cable Section length;
(3) Sections of the primary cable containment to be used; and
(4) Sections of additional cable supports to be provided by the Contractor with details on dimension and type of the cable supports such as cable trays, trunkings and conduits.

15.4.4 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.

15.4.5 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.

15.4.6 The Contractor shall provide his own 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 lids prior to and after cable installation.

15.4.7 Selection of cables and connectors shall be appropriate to their function. The Contractor must be able to demonstrate satisfactory usage of the type of cables proposed for use under tropical conditions, be able to comply fully with the specifications herein and guarantee 25 years or more of service life for all the cables.

15.4.8 All cables shall be anti-termite, pest resistant and rodent-proof and resistant to any kind of corrosion due to soil & environmental conditions and shall be suitable for use and also be immunised from degradation under the following atmospheric impurities and environmental conditions:

(1) Total immersion in water, acidic solutions with low concentration, salty media, etc;
(2) Exposure to toxic materials dirt, dust, grease, oil, hazardous gases, etc;
(3) Abrasion as a result of vibration and shock';
(4) Lubricating and diesel oil;
(5) Exposed to acids and salts which may be present in concrete structures, soil, ballast etc;
(6) Exposed to atmospheric conditions including direct/indirect sunlight and the various substances present in industrial and seaside areas;
(7) Vapour from phenolic materials;
(8) Chlorine from plastics;
(9) Sulphur from rubber;
(10) Ozone;
(11) Iron, Copper and dust; and
(12) Cleaning Vapour solution.

15.4.9 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. A record shall be provided to indicate clearly the type of cables, the sizes of cable, the use of each core or pair, and termination as well.

15.4.10 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 also be adopted:

During track crossings, following rules shall be observed:

(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 concrete/GI pipes while crossing the track.

(4) The cables other than optic fiber are laid at a depth of 1.0 metre below the bottom of the rail.

15.4.10.1 At culverts the cables shall be suitably supported and protected with B-class GI pipes.

15.4.10.2 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.

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

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

15.4.13 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.

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

15.4.15 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.

15.4.16 Unused cable cores/pairs of multi-core/pair cables shall also be terminated and marked so or be neatly tied and wrapped up inside the connectors if termination is not possible.

15.4.17 All RF joints outside the cabinets shall be sealed by waterproof tapes or jackets. These tapes or jackets shall be further resistant to ultra-violet light when the cable joints are located in areas exposed to sunlight.

15.4.18 For metallic armour of the fiber optic cable and of outdoor telephone cables an earthing and gapping policy shall be incorporated into an overall earthing policy agreed by the Engineer.

15.4.19 Each fiber splice shall be tested to ensure correct fiber continuity and splice loss.

15.5 Marshalling and Termination

15.5.1 General

15.5.1.1 Main distribution frames, digital distribution frames and optical distribution frames shall be provided at appropriate locations for signal termination, distribution, disconnection, diversion and in-circuit testing. Intermediate termination points shall also be provided as appropriate to allow cable network flexibility.

15.5.1.2 The signal termination and distribution practice shall adopt a consistent approach for easy circuit identification and is subject to the review of the Engineer.

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

15.5.1.4 These frames shall be designed to allow repeated circuit termination and disconnection.

15.5.2 Main Distribution Frame

15.5.2.1 Main distribution frame with 25% extra capacity for future expansion shall be provided at Telecommunication Equipment Room and Central Equipment Room for the signal distribution of all voice, analogue, alarm and control circuits.

15.5.2.2 The Contractor shall provide at least five sets of the following accessories at each location where the main distribution frame is installed:

(1) tools for circuits connection and disconnection
(2) plug-in devices for circuit disconnection
(3) test cords and loop-back cords
(4) signal patch cords

15.5.2.3 The outgoing circuits connecting to external lines and all 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 Transient Protection please refer to15.8 (Transient and Lightning Protection)

15.5.2.4 All voice, analogue, alarm and control circuits including spares shall be properly terminated at the main distribution frame.

15.5.2.5 The main distribution frame shall be divided into different zones for different types of circuits.

15.5.2.6 The main distribution frame 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 15.7.4 (Earthing policy).

15.5.2.7 The main distribution frame shall be equipped with facilities such as use of different colours or markers to aid circuit pairs identification.

15.5.2.8 The Contractor shall maintain records of all the circuit terminations.

15.5.3 Digital Distribution Frame

15.5.3.1 Digital distribution frame shall be provided at Telecommunication Equipment Room, Central Equipment Room and at other locations as appropriate for data circuit termination.

15.5.3.2 The Contractor shall provide at least five sets of the following accessories at each location where the digital distribution frame is installed:

(1) plug-in devices for circuit disconnection
(2) test cords and loop-back cords
(3) signal patch cords.

15.5.3.3 Different modules in the digital distribution frame shall be provided for different types of data circuits.

15.5.3.4 The digital distribution frame shall be equipped with sufficient capacity for data circuits including spare circuits. The digital distribution frame shall also be equipped with an extra of 20% of termination capacity for future use.

15.5.3.5 Markers or labels shall be included in the digital distribution frame for easy identification of the circuits.

15.5.4 Optical Distribution Frame

15.5.4.1 Optical distribution frame shall be provided at Telecommunication Equipment Room, Central Equipment Room, and at other locations as appropriate for optical signal distribution and spare fiber cores storage.

15.5.4.2 The optical distribution frame shall comprise of equipment cabinet(s) or enclosures housing,

(1) fiber splice module
(2) fiber storage panel
(3) optical patch panel

15.5.4.3 All fiber cores terminating in the optical distribution frame shall be spliced to factory manufactured pigtails or properly stored in the fiber storage panel.

15.5.4.4 Optical patch cords shall be provided to connect the optical terminal to the optical distribution frame and for patching within and between optical patch panels.

15.5.4.5 Fiber storage panels shall be provided in the optical distribution frame to stow the excess length of pigtail and patch cords.

15.5.4.6 All splices shall be fusion splices and heat shrink splice sleeves shall be used for splice protection and housed in a fiber splice module.

15.5.4.7 All fiber splice modules shall be either telescopic or hinged type for easy access of splice elements.

15.5.4.8 All fiber splice modules shall be equipped with built-in fiber slack take-up mechanism.

15.5.4.9 All optical distribution panels shall be either telescopic or hinged type for easy access of rear side of panels. The optical distribution panel shall be fully equipped with adapters for optical signal termination.

15.5.4.10 All spare adapters shall be protected with jackets.

15.5.4.11 One high quality optical connector such as FC/PC single mode 10/125µm type shall be standardised. Optical connector type specified on the transmission equipment shall be compatible with the optic fiber termination. The coupling loss of the connector shall be below 0.3 dB.

15.5.4.12 All optical connectors shall comply with the ITU-T Recommendation G.652.

15.5.4.13 Mating face dimensions in accordance with IEC 86B.

15.5.4.14 All pigtails and patch cords shall be properly labelled.

15.5.4.15 The optical distribution frame shall be equipped with sufficient capacity for all optical signal distribution and fiber storage. An extra of 20% capacity in each module shall be provided for future expansion.

15.6 Identification

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

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

15.6.3 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.

15.6.4 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.

15.6.5 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.

15.6.6 Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical or optical laser equipment.

15.7 Electrical Distribution

15.7.1 Telecom equipment for sub systems of Master Clock, Video Surveillance and Data network shall be powered from 230 Volts Ac supply from the Power Supply System (PSS) being provided by ST P-5 contractor.

15.7.2 Telecom equipment for sub systems of Optical Fiber Communication, GSM® Radio and EPABX etc shall be powered from 48 Volt DC Battery Backup System.

15.7.3 Power supply distribution Panels for AC and DC supplies shall be provided by the contractor. Design for the distribution panels shall be submitted to the Engineer for review. Distribution panels shall have adequate spare circuits for each system and each rating.

15.7.4 Earthing Policy

15.7.4.1 General

15.7.4.1.1 Earthing shall be provided for all indoor & outdoor Telecommunication 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 due to electrostatic induction;
(2) to ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the Telecommunication equipments;
(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;
(4) to serve as common voltage reference point wherever required.

15.7.4.1.2 Earthing and other protective measures in the following paras are given only as indicative guidelines. ST P-5 contractor shall design, manufacture, install and be responsible for safe and correct working of all equipment/subsystems under the scope of the contract.

15.7.4.1.3 ST P-5 contractor shall submit, for review and approval the design for earthing, transient protection and lightning protection of all telecommunication subsystems including earthing and lightning protection of the radio tower. OEM's original data sheets of the proposed devices shall also be submitted.

15.7.4.2 Requirements of effective Earthing

15.7.4.2.1 The Earthing system shall meet or exceed the requirements of IEEE 1100, NFPA 780 and IEC 1024 or relevant International standards.

15.7.4.2.2 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; and
(5) provide a clean zero-volt reference point where required.

15.7.4.2.3 The earthing system shall be so designed so as to give earth resistance within the stipulated limits at all locations and under all climatic conditions.

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

15.7.4.2.5 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.

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

15.7.4.3 Earthing of indoor equipment

15.7.4.3.1 Civil Contractors shall make available their main Earth Bus in the station building and ST P-5 contractor shall extend it to his equipment rooms.

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

15.7.4.3.3 The cabinets within a row are to be conductively connected by means of screws and contact washers. Two or more rows are interconnected via the earth bus and if necessary, also by additional earthing cables. In case that one of the cabinets/racks is removed, it must be ensured that the other cabinets in the row remain earthed

15.7.4.4 Earthing of outdoor installations

15.7.4.4.1 Outdoor installations, listed below, shall be earthed to the nearest Main earth bus bar with a minimum 16 mm² copper conductor:

(1) metallic sheath & armouring of all cables at regular intervals;
(2) location boxes;
(3) racks;
(4) video cameras;
(5) clocks display units;
(6) any other telecommunication installation as may be necessary to cover complete scope of works defined in the Contract.

15.7.4.4.2 The contractor may make use of Buried Earth Conductor along the main line, if provided by EMP-4 contractor.

15.7.4.4.3 Long runs of fiber optic armoured telecommunications cables along the trackside shall have isolating sections installed as required to keep within the ITU-T maximum allowable recommendations for induced voltage.

15.7.4.5 An earthing system shall be designed to assure personnel safety and protection of installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances.

15.7.4.6 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.

15.7.4.7 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 common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

15.7.4.8 The Contractor shall provide two separate earth connections, a clean earth connection to the earth terminals provided inside the rooms where the telecom equipment is installed, and a main earth connection for the earthing of radio towers, antenna feeder cables, equipment chassis, etc. of the telecommunication system.

15.7.4.9 The earthing system shall meet, but not be limited to, the following:

(1) The resistance to earth of the system “earth terminal” must remain within the stipulated limits at all locations and under all climatic conditions.
(2) Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.

15.7.4.10 The earthing arrangements for Antenna Towers and Antennae shall be such that:

(1) The zone of coverage shall afford protection of all objects forming part of the Antenna Towers and Antennae including any objects near the base of the tower, and this factor shall be taken into consideration while deciding the height of the lightning conductor at the top of the tower.
(2) Earthing of VHF/UHF Antenna Feeder Cables having Copper Sheaths shall be such as to maintain a low resistance connection to the earth. Any junction forming a part of this connection shall be protected from moisture ingress by using proper wrapping, sealing with water-proof tapes, or such other measures.

15.7.4.11 The earthing arrangements for Telecom Equipment shall be as below:

(1) All Telecom equipment must be protected using a mesh of copper “earth” strips of appropriate cross-sectional dimensions, forming a local clean earth bus.
(2) Each equipment rack shall be connected electrically to this bus. This bus shall be connected to the external ring earth at the shortest possible distance from two opposite points of this bus.
(3) All joints of this connection shall be protected from moisture ingress by using proper wrapping, sealing with water-proof tapes, or such other measures.

15.7.4.12 The metallic sheath and armouring of all cables (RF cables/optical fiber cable/others) shall require earthing.

(1) In the section earthing shall be done as per the established practices in RE areas of the Indian Railways.

15.7.4.13 The earthing electrodes for the clean earth shall be located at least 20 m away from the main earth.

15.7.4.14 The route for the clean earth shall be so chosen as to minimise the effect of any inductive interference.

15.7.4.15 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.

15.7.4.16 The earth resistance at any point on the clean earth shall be below 0.5 Ohm, and that for the main earth shall not exceed 1.0 Ohm at any location and under any soil and/or climatic condition.

15.7.4.17 All metal work and metallic items shall be earthed to the main earth to ensure the safety of personnel.

15.7.4.18 The earthing methods and details shall be submitted to the Engineer for review.

15.7.4.19 Radio equipment shall be provided with isolated terminations for the connection of coaxial cables extending to equipment in external locations.

15.8 Transient and Lightning Protection

15.8.1 General

15.8.1.1 Effective transient protection system, complying to the following as a minimum must be provided to protect the telecommunication equipment from transients:

(1) Peak transients of up to 700 Volts on the DC Power Supply line for several microseconds.

(2) Average transient duration of 2 microseconds with a repetition frequency of 15kHz to 100kHz

(3) For short duration transients (< 5ms) the variation approaches a sine wave

(4) For longer duration transients (> 5ms) the variation approaches rectangular pulses with an initial rate of rise up to 5x10^4 Volts per second

15.8.1.2 Suitable electronic devices (such as silicon avalanche suppressor devices/transzorbs) having high surge handling capability, fast response time and low clamping voltage, etc; shall be incorporated in the telecommunication equipment to ensure that the latter withstands the above mentioned conditions without any damage or permanent degradation in performance throughout the system lifetime. The selection criteria for such devices shall include, but not be limited to, the following:

(1) reverse standoff voltage shall be atleast twice the maximum operating voltage;

(2) pulse power rating shall be adequate to handle the peak pulse power of the transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from overhead traction power system;

(3) device lifetime shall not be less than that of the system for which it affords protection.

15.8.1.3 Surge protection devices shall be provided at TER end and outdoor equipment end, on power and data cables extending to outdoor telecommunication equipment installations as a minimum as defined below

(1) video cameras & Monitors surge protection devices at both ends;

(2) clock displays surge protection devices at both ends

(3) radio frequency feeder cables separately for each individual cable of GSM-R antenna & GPS antenna on both ends;

(4) armour of optical fiber cable shall be directly earthed at TER end and earthed through a surge protection device at the other end station;

15.8.1.4 Earthing requirements for each system, as a minimum, are summarized in table 15-1 below:

Sub-system	Surge Protection for outdoor equipment			Surge Protection for indoor equipment		
	Equipment	Power Line	Data Line	Equipment	Power Cable	Data Line
OFC communication system	ODF	Earthing for optical fiber cable armour		SDH Node	Yes	yes
				Data Network Equipment	Yes	Note 1
Telephone System	Outdoor telephones	Yes	Yes	LDF	N/A	yes
				MDF (incoming leased telephone line)	N/A	Yes
Clock	Slave Clocks out door	Yes	Yes	Sub-master Clock / changeover switch	No	Yes
Video Surveillance system	Video camera	Yes	Yes	Video Surveillance system cabinet	No	Yes
	Video Monitor (MMI)	Yes	Yes			
SCADA	Depending upon the kind of interface					
Battery system				SMPS	Yes	N/A

Table 15-1 Application of Surge protection measures

Note: 1 internal protection

15.8.1.5 Earthing and other protective measures in para above are given only as indicative guidelines. Contractor shall design the earthing system for the complete telecom system for each location and submit to the Engineer for review

15.8.2 Lightning Protection

15.8.2.1 While the station buildings will be provided with the lightning protection arrangements by other project contractors, the protection against lightning surges travelling through conductors into equipment shall be provided by ST P-5 contractor using appropriate devices.

15.8.3 The Contractor shall submit the proposed measures for review by the Engineer.

15.9 Housing, Enclosure and Cabinet

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

15.9.2 All design of housing and enclosure shall be submit to the Engineer for review.

15.9.3 Unless specified otherwise, all equipment to be housed in outdoor environment (open areas, etc) shall be with IP 65 enclosures as a minimum.

∗ End of Chapter 15 ∗

16 OPERATION AND MAINTENANCE SUPPORT

16.1 General

16.1.1 The Contractor shall investigate all failures, major failures, repetitive failures, design defects and provide all necessary corrective actions throughout the Contract period.

16.1.2 The Contractor shall investigate interference problems either from or to the systems of other Project Contractors and organisations (mobile cellular communication operators etc) other than WDFC and provide all necessary corrective actions throughout the Contract period.

16.2 Operation and Maintenance Documentation

16.2.1 The Contractor shall prepare Operation and Maintenance documentation and the Employer's Operation and Maintenance Manual Specification.

16.2.2 The first submission shall be made to the Engineer for review at least nine months prior to the issue of the Substantial Completion Certificate for the Works.

16.3 Maintenance Plan

16.3.1 The Contractor shall submit a Maintenance Plan in accordance with provisions in GS to the Engineer for review before the commencement of installation activities.

16.3.2 The Maintenance Plan shall describe the Contractor's proposed maintenance regime for preventive and corrective maintenance of the System, including, but not be limited to the following:

(1) the maintenance philosophy and approach;
(2) all necessary tasks for first line, second line, third line and corrective maintenance; and
(3) frequency of each maintenance task.

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

(1) the equipment, subsystems covered in the task;
(2) step by step procedure to carry out the task;
(3) tools and test equipment list of each task;
(4) diagrams and flowcharts for illustration, if applicable;
(5) recovery procedures, if applicable;
(6) precautions the maintenance personnel to follow; and
(7) estimated duration and manpower required.

16.3.4 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.

16.4 Software Support

16.4.1 General

16.4.1.1 It shall be in compliance with requirement of GS.

16.4.2 Security Obligations

16.4.2.1 The Contractor shall be in compliance with the requirements of GS.

16.5 Support during Defects Liability Period

16.5.1 General

16.5.1.1 During the Defects Liability Period, maintenance will be conducted by the Employer with the support of the Contractor.

16.5.1.2 The Contractor shall provide workshop repair services of all defective and faulty items of the System.

16.5.1.3 The Contractor shall provide support and call-out services to the Employer as required to restore the System to normal operation in case faults and defects are found.

16.5.1.4 The Contractor shall submit a maintenance manpower plan showing the Contractor's organization level available during the Defects Liability Period

16.5.1.5 The Contractor shall ensure all his staff who provide maintenance support shall be competent and with sufficient training in the responsible subsystems. CVs of the proposed staff shall be submitted to the Engineer for review.

16.5.2 Workshop Repair

16.5.2.1 The Contractor shall collect and repair defective parts that are removed from the System during maintenance and collected from the Employer.

16.5.2.2 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.

16.5.2.3 The Contractor shall use only components of equal or higher specification than the original components in his repair activities.

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

16.5.2.5 The maximum turnaround time for workshop repair shall be less than 28 calendar days. The turnaround time is started to count when the defective parts are removed from the System and ended when the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

16.5.3 Support and Call-out Services

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

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

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

16.5.3.4 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.

16.5.3.5 The Contractor's staff shall be available on Site for maintenance support within two hour upon receiving the call-out request from the Employer and shall proceed to perform corrective actions to restore the System to full normal operation.

16.5.3.6 The Contractor shall take every precaution to protect existing equipment from damage, and make good any damage caused.

16.5.3.7 Shall any abnormal system behaviour like intermittent faults, interference, frequent repeated faults, etc, or the performance be found to deviate from the specified tolerances, the Contractor shall conduct investigation and report the findings to the Engineer together with the recommendation and proceed after the recommendation has been reviewed without objection by the Engineer.

16.5.4 Monthly Maintenance Meeting

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

∗ End of Chapter 16 ∗

17 SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

17.1 Spares

17.1.1 General

17.1.1.1 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.

17.1.1.2 The Contractor shall submit the lists of spares six months before the start of DLP to the Engineer for review. The lists shall include:

(1) grouping by Subsystem, diagnostic and test equipment and special tools, as applicable, for stocking identification

(2) a cross-reference and indexing system for replacement components common to more than one subsystem

(3) detailed description with references and correlation with the maintenance manuals

17.1.2 Contractor's Own Spares

17.1.2.1 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:

(1) the expected failure rate of the parts;

(2) population of the parts in the System;

(3) criticality of the parts in the System;

(4) availability and MTTR figures of the System;

(5) spare delivery lead time; and

(6) workshop repair turnaround time.

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

17.1.2.3 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 months before the commencement of the Defects Liability Period to the Engineer for review.

17.1.2.4 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.

17.1.3 Contract Spares for Employer's Operational and Maintenance Requirements

17.1.3.1 The Contract spares as a minimum shall be supplied as per the list specified in Appendix 5. Contractor shall submit list of spares with quantities and other details in accordance with the provisions of chapter 27 of GS. However for those of the spares not specifically included in this list but considered essential, the Contractor shall include a list of recommended additional spares worked out in accordance with provisions in the GS.

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

17.1.3.3 The Contractor shall submit item-wise unit price list with quantities of each type of spare modules, sub-assemblies, and parts in the list of Employer's requirements and those recommended by the Contractor.

17.2 Special Tools and Test Equipment

17.2.1 The Contractor shall provide his own test equipment and tools during the installation, commissioning periods and Defects Liability Period.

17.2.2 The Tools and Test Equipment shall as a minimum be supplied as per the list specified in Appendix 6. For those of the Tools and Test Equipments not specifically provided for in this list but considered necessary the Contractor shall submit a list of additional recommended special tools and test equipment with proposed quantities, together with the catalogue, brochure and specifications, to the Engineer for review before the commencement of installation.

17.2.3 The recommended special tools and test equipment shall be of appropriate types and sufficient quantities to enable the Employer to carry out his own operation and maintenance of the System. Test equipment shall be recommended for the purpose of testing, trouble shooting, programme diagnosis and equipment calibration.

17.2.4 All special tools and test equipment shall be supplied together with all cords connectors and operation manuals, complete diagrams, schematics, assembly and connection drawings, maintenance and calibration instructions.

17.2.5 None of the special tools and test equipment provided for the Employer shall be used on Site prior to delivery to the Employer.

17.2.6 Contractor shall submit list of Special Tools & Test Equipment at least six months before the start of defects liability period to the Engineer. The supply of Special Tools & Test Equipment shall be completed by the start of defects liability period.

17.3 Spares and Special Tools & Test Equipment

17.3.1 Computer based Spares and Special Tools & Test Equipment inventory management plan shall be established for management of inventory by the Employer.

∗ End of Chapter 17 ∗

18 TRAINING

18.1 General Requirements

18.1.1 The contractor shall provide comprehensive training to the employer's staff, including employer's trainers, in accordance with the requirements contained in this particular specification and in the general specification.

18.1.2 The contractor shall provide competent training instructors, training manuals, training simulators, all necessary aids and materials as required for all the training courses.

18.1.3 All the training courses shall be conducted during installation period and completed before the commencement of testing and commissioning. No training course shall be started before the completion of Design phase.

18.1.4 The training courses shall be conducted at manufacturers' place and at the site(s) or in DFCCIL Corporate/Regional Office.

18.1.5 The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possess good communication skills in English.

18.1.6 The training instructors shall be either the system designer or engineering staff of the contractor, the contractor's subcontractors or the equipment manufacturers.

18.2 Training Plan

18.2.1 Within sixty days after the Commencement Date of the Works, the Contractor shall submit a Training Plan to the Engineer for review.

18.2.2 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.

18.3 Training Courses

18.3.1 The Contractor shall provide training courses for each of the Subsystems, including, but not be limited to:

(1) Optical Fiber Communication System;
(2) Data Networking System
(3) GSM-R radio system;
(4) Telephone system including EPABX and dispatch telephone system;
(5) Master clock system; and
(6) Surveillance system.

18.3.2 The number of trainees from different disciplines shall not be less than:

(1) thirty for Employer's operations staff at site;
(2) thirty for Employer's maintenance staff at contractor's works/site; and
(3) Employer's engineering personnel overseas at contractors / subcontractor's works as detailed below:

S. No.	Description	Total Period (Months)	Remarks
1	Design of Optical Fiber Communication System	1	During the Design Stage
2	Design of GSM-R radio System	1	During the Design Stage
3	Design of PABX System	1	During the Design Stage
4	Design of Dispatch Telephone System	1	During the Design Stage
5	Design of Master Clock System	0.5	During the Design Stage
6	Design of Surveillance System	0.5	During the Design Stage
7	Design of Battery Backup System	0.5	During the Design Stage
8	Short Module course on: System description, architecture and installation practices of OFC system, Clock system, CCTV, Battery Backup system	1	
9	Short Module course on: System description, architecture and installation practices of Radio System, PABX and Dispatch Telephone system	1	

(4) two for Employer's Training Instructors at contractors works /site

18.3.3 Different types of training courses of each Subsystem shall be provided for staff from different disciplines. Operations training courses shall be provided for the operations staff. System engineering and maintenance courses shall be provided for engineering and maintenance staff. The Employer's Training Instructors shall attend all types of training courses such that the Employer's Training Instructors shall be able to subsequently train the Employer's staff in all aspects of operation and maintenance of the System.

18.3.4 The maximum number of trainees of each training class shall normally not be more than fifteen. Class size larger than fifteen shall be subject to the review of the Engineer.

18.3.5 The Contractor shall determine the number of classes for each type of training course to ensure the objectives of the course can be met.

18.3.6 Operations Training Courses

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

(1) overview of the Telecommunications System;

(2) brief description of the operation principle of the Subsystem;
(3) operational features and functions;
(4) familiarisation and use of all man-machine interfaces involved;
(5) reading and interpretation of system status and alarm messages or indications;
(6) normal operating procedures;
(7) operating procedures under emergency situations;
(8) procedures for recovery from minor or simple faults; and
(9) use of Operation and Maintenance Manuals and documentation.

18.3.6.2 Particular exercises shall be included in the operations training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple faults recovery.

18.3.7 System Engineering and Maintenance Courses

18.3.7.1 The system engineering and maintenance courses shall be developed to provide all necessary knowledge and skills:
(1) to perform full maintenance, including both preventive and corrective maintenance, on the System; and
(2) to perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits.

18.3.7.2 The Contractor shall determine the content of the courses and the courses shall include the following as minimum:
(1) overview of the Telecommunications System;
(2) background theory;
(3) system features and functions;
(4) system configuration and operation principles;
(5) description of system components and equipment down to card or module level;
(6) test and commissioning procedures;
(7) use of test equipment and special tools;
(8) reading and interpretation of alarm indications, messages and print-outs;
(9) preventive maintenance procedures;
(10) fault diagnosis, troubleshooting and corrective maintenance procedures;
(11) equipment settings and parameters configuration;
(12) use of equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;
(13) methods and procedures to provide new circuits, system expansion and enhancement;
(14) data, software backup and loading; and
(15) use of software such as peripheral control and configuration, utility, database structure, generation and modification.

18.3.7.3 Practical exercises shall be provided for each trainee to practise the following as minimum:
(1) use of test equipment and special tools;
(2) preventive maintenance;
(3) fault diagnosis and troubleshooting with induced faults set by the Contractor to simulate real-life situation; and
(4) faulty modules or cards replacement and restore the system to normal operation.

18.4 Training Materials

18.4.1 At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form allow easy future reproduction.

18.4.2 The format of the trainer's guides and training manual for trainees shall be submitted to the Engineer for review.

18.4.3 The Contractor shall, for each course, distribute two sets of trainer's guides, one set of training manual for each trainee, two sets of trainer's guides and three additional sets of training manual to the Engineer before the commencement of the training course.

18.4.4 The trainer's guide shall be prepared in accordance with the requirements given in the GS.

18.4.5 All the training materials shall be accurate and match with the actual Design of the System.

18.5 Training Records

18.5.1 The Contractor shall devise a system, standards for 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 four weeks before the commencement of the training course.

18.5.2 The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.

18.6 Course Evaluation

18.6.1 The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Engineer for review four weeks before the commencement of the training course.

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

18.6.3 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.

18.6.4 The contractor shall submit the course evaluation criteria to the Engineer for .approval.

∗ End of Chapter 18 ∗

19 DOCUMENTATION

19.1 General

19.1.1 The Contractor shall submit a Submission Programme. The Submission Programme shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

19.1.2 The Contractor shall provide configuration management to ensure that the System is correctly configured. The Contractor shall ensure that a configuration control programme is maintained. The programme shall ensure that the configuration of each item is recorded and maintained during the life of the Contract and Defects Liability Period.

19.1.3 The Contractor shall submit a Project Management Plan to the Engineer for review as laid down in the GS. The Project Management Plan shall identify the persons to be responsible and the methods and arrangement to carry out the Project Management.

19.2 Submission Requirement

19.2.1 General

19.2.1.1 The Contractor shall include records of amendment in each submission with the following details:

(1) revision history and status of the submissions;
(2) description on changes for each revision; and
(3) the Contractor's signature for authorisation of the submission indicating proper Design check has been carried out before submitting to the Engineer.

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

19.2.1.3 The first submission shall be revision 0 and subsequent revision shall be A, then B, so and so forth.

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

(1) submission number;
(2) submission title;
(3) revision history;
(4) status of Engineer's Response for each revision;
(5) submission dates and dates of return from the Engineer for each revision; and
(6) Current status.

19.2.2 Levels of Submission

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

(1) system level related submission;
(2) equipment level related submission;
(3) installation Design related submission;
(4) design calculations;
(5) management plans and procedures;
(6) approval certificates; and
(7) Miscellaneous submission.

19.2.2.2 System level related submission 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 Project Contractors.

19.2.2.3 Equipment level related submissions shall show the specifications on electrical, mechanical and functionality of the equipment/materials employed for the System and the Subsystems.

19.2.2.4 Installation design related submissions shall include:

(1) the installation methods and procedures for different types of installation activities;
(2) drawings showing the equipment locations and positions, Subsystems coverage;
(3) schematic and wiring diagrams;
(4) cable core plan and numbering scheme;
(5) equipment mounting details;
(6) configuration data, parameters and settings;
(7) cable route drawings; and
(8) layouts in equipment racks, in equipment rooms, trackside, and all other equipment locations.

19.2.2.5 Design calculations shall demonstrate the performance of the System and Subsystems. Detailed requirements on calculation submissions are given in respective sections of individual Subsystem.

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

19.3 As built-documentation

19.3.1 The as-built documentation shall describe the System as installed and provide sufficient information for other users, maintainers and developers to execute their responsibilities. All documentation shall be submitted for review by the Engineer, and shall include but not be limited to:

(1) Operation and Maintenance Manuals;
(2) Configuration Data Tables; and
(3) As-built drawings.

19.3.2 The configuration data tables shall be prepared for each individual Subsystem and on an item-by-item basis as well as on location basis.

19.3.3 The as-built drawings shall show the as-built details of the Works and shall include:

(1) bill of quantity of equipment on location basis;
(2) location and connectivity of all equipment and cables;
(3) schematic and wiring diagrams;
(4) cable core plan and numbering scheme;
(5) equipment mounting details;
(6) cable route drawings; and
(7) layouts in equipment racks, equipment rooms, trackside and all other equipment locations.

∗ End of Chapter 19 ∗

20 PROGRAMME REQUIREMENTS

20.1 Coordination Events and Key Milestones

20.1.1 Coordination Events and Key Milestones are as given in the Volume 1.

20.1.2 Major installation works in the stations and ancillary buildings requiring co-ordination with the Civil Works Project Contractors shall be co-ordinated as per provisions in interface requirements.

∗ End of Chapter 20 ∗

APPENDICES

APPENDIX 1: EPABX TELEPHONE LOCATION AND QUANTITY

S. N	Name of Station	Crew Changing building	IMD	IM Sub-Depot	OHE Depot WT	STATION BLDG	Service Building	TWS	MMU	SUB-DEPOT Break down	Track Machine Depot	Residential Buildings	EPABX Phones for IR station	Total EPABX Phones	Auto Location Hut & Telecom Porta Hut	Total EPABX Phones (including 10% spares)	TYPE/SIZE OF EPABX
1	**Rewari**	**5**	**60**		**2**	**22**	**12**	**1**	**6**		5	30	**10**	153	**10**	**178**	**S2**
2	**Ateli**			**12**		**22**	**12**			**10**	**5**	**30**	**10**	**101**	**10**	**121**	**S3**
3	Dabla			12		16	12		6	10	5	18		79	10	97	S3
4	Bhagega			12		16	12			10		12		62	10	78	S3
5	Shrimadhpur		60			16	12	1	6	10	5	30		140	10	164	S2
6	Pachar Malikpur			12		16	12			10		12		62	10	78	S3
7	**Phulera**					**22**	**12**		**6**	**10**	5	30	**10**	95	**10**	**115**	**S3**
8	Sakun			12		16	12			10		12		62	10	78	S3
9	Kishangarh			12		16	12		6	10	5	30		91	10	110	S3
10	Sardana		60			16	12	1		10	5	24		128	10	151	S2
11	**Bangugram**			**12**		**16**	**12**		**6**	**10**	**5**	**12**		**73**	**10**	**90**	**S3**
12	Haripur			12		16	12			10		12		62	10	78	S3
13	Chandaval			12		16	12			10		12		62	10	78	S3
14	**Marwar**	**5**	**60**			**22**	**12**	**1**	**6**		5	24	**10**	145	**10**	**170**	**S2**
15	Jwali			12		16	12			10		12		62	10	78	S3
16	Biroliya			12		16	12			10		12		62	10	78	S3
17	Keshavganj		60			16	12	1	6	10	5	12		122	10	144	S2
18	Banas					16	12			10		24		62	10	78	S3
19	Swarupganj			12		16	12		6	10	5	12		73	10	90	S3
20	Siriamirgarh			12		16	12			10	5	12		67	10	84	S3
21	Chadotar					**16**	**2**							**18**	10	22	S4
22	**Palanpur**		**60**			**22**	**12**		**6**		**5**	**30**	**10**	**145**	**10**	**170**	**S2**
23	Malosan			12		16	12		6	10	5	14		75	10	93	S3
24	**Mehesana**			**12**	**2**	**22**	**12**		**6**		**5**	**30**	**10**	**99**	**10**	**119**	**S3**
25	Ghumasan			12		16	12			10	5	14		69	10	86	S3
26	**Sabarmati North**					**22**	**12**		**6**		**5**	**30**	**10**	97	**10**	**117**	**S3**
27	**Sabarmati South**		**60**			**22**	**12**		**6**		**5**	**32**	**10**	**147**	**10**	**162**	**S2**
28	Timba			12		16	12			10	5	14		69	10	86	**S3**
29	Changa			12	2	16	12	1	6	10	5	10		74	10	91	**S3**
30	Vasad			12		16	12			10	5	10		65	10	82	**S3**
31	**Makarpura**	**5**	**60**			**22**	**12**	**1**	**6**		**5**	**12**	**10**	**133**	**10**	**156**	**S2**
32	**OCC/ Ahmedabad**.													200		200	S1

Notes:

1. Requirements of Telephone extensions are tentative to be developed during design phase.
2. Type/Size of EPABX
   a) S1 ---- Equipped Ports Nos. 256, Wired Ports Nos. 512 & Expandable Ports Nos. 512

b) S2---- Equipped Ports Nos. 256, Wired Ports Nos. 256 & Expandable Ports Nos. 256
c) S3 ---- Equipped Ports Nos. 128, Wired Ports Nos. 256 & Expandable Ports Nos. 256.
d) S4 ---- Equipped Ports Nos. 48, Wired Ports Nos. 96 & Expandable Ports Nos. 96

APPENDIX 2: DISPATCH TELEPHONE CONSOLE MATRIX

	OCC	No of Consoles	No of External Connections	No of Inter-console Connections	No of Strategic Locations	Total No of lines
	Chief Controller (CC)	1(1)	1. IR OCC 6(8) 2. IR station 10(16) 3. Emergency lines 3(6)	1. OCC Consoles 12(15) 2. Station Control Room 31(48) 3. Depot Controller 1(1) (provided by RS P-7)	Nil	63(94)
	Deputy Chief Controller (Dy CC)	1(1)	1. IR OCC 6(8) 2. IR station 10(16) 3 Emergency lines 3(6)	1. OCC Consoles 12(15) 2. Station Control Room 31(48) 3. Depot Controller 1(1) (provided by RS P-7)	Nil	63(94)
	Chief Power Controller (C-TPC)	1(1)	Nil	1. OCC Console 12(15)	1. TSS 2. SPs & SSPs 3. IMD/IM Sub depot 31(48)	To be developed during design
	Traffic Controller (TC)	3(5)	1. IR Junction Station 10(16) 2. IR OCC 6(8)	1. OCC Consoles 12(15) 2. Station Control Room 31(48) 3. Depot Controller 1(1) (provided by RS P-7)	Nil	60(88)
	S&T Control Signal	1(1)	Nil	1. OCC Consoles 12(15) 2. Station Control Room 31(48) 3. Signalling Equipment Rooms 31 (48)	IMD/IM Sub depot 31(48)	105(159)
	S&T Control Telecom	1(1)	Nil	1. OCC Consoles 12(15) 2. Station Control Room 31(48) 3. TER 31(48)	IMD/IM Sub depot 31(48)	105(159)

APPENDIX 2: DISPATCH TELEPHONE CONSOLE MATRIX						
	OCC	**No of Consoles**	**No of External Connections**	**No of Inter-console Connections**	**No of Strategic Locations**	**Total No of lines**
	Traction Power Controller (TPC)	2(3)	Nil	1. OCC Console 12(15)	1. TSS 2. SPs, SSPs 3. IMD/ IM Sub depot 31(48)	To be developed during design
	Crew/Traction Locomotive Controller	1		1. OCC Console 12(15) 2. ELMD Controller 1(1)	To developed during design	To be developed during design
	Engineering Controller	1(1)	Nil	1. OCC Consoles 12(15) 2. Station Control Room 31(48)	. IMD/ IM Sub depot 31(48)	(74/111)
ELMD						
	Depot Controller	1(1)	Nil	1. DyCC Console 2(2) 2. TC Console 3(5) 3. Traction Locomotive Controller 1(1) 4. Rewari Station 1(1)	Local extensions within ELMD (scope of ELMD)	scope of RS P-7
Station Control Room						

APPENDIX 2: DISPATCH TELEPHONE CONSOLE MATRIX						
	OCC	**No of Consoles**	**No of External Connections**	**No of Inter-console Connections**	**No of Strategic Locations**	**Total No of lines**
	Station Master (SCR)	31(48)	1. IR Station 1(1) 2. IR OCC 1(1) (for Junction Station only)	1. CC/Dy.CC Console 1(1) 2. TC Console 3(5) 3. Adjacent Junction/Crossing Stations 4(4)	1. Gateman Telephone at Level Crossing 2. IMD/ IM Sub depot 4 3. Residential Building 3 4. Other stations of WDFC	To be developed during design
	x(y) : x – Phase 1 estimated quantity y - Phase 1 & 2 estimated quantity Dispatch Telephone Console Matrix is very tentative. Contractor shall develop the matrix during design and submit to the Engineer for review.					

End of Appendix2

APPENDIX 3: MMI (RDW & DTS CONSOLES) PROVISION SCHEDULE

MMI Provision Schedule				
Location	**S.N**	**Position**	**Dispatcher's Consoles**	
			Type	**Quantity**
OCC	**1**	**Traffic Controller (TC1)**	**Dispatcher's Radio Console**	**1**
			DTS Telephone Console (100 LINES)	1
	2	**Traffic Controller (TC2)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	3	**Traffic Controller (TC3)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	4	**Chief Controller (CC)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	5	**Deputy Chief Controller**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	6	**Traction Power Controller (TPC1)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	7	**Traction Power Controller (TPC2)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	8	**Chief Traction Power Controller (C-TPC)**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	9	**Crew Controller/Traction Locomotive Controller**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	10	**Signal Controller**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	11	**Telecom Controller**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	12	**Engineering Controller**	**Dispatcher's Radio Console**	1
			DTS Console (100 LINES)	1
	13	**Security Control**	*CCTV monitor console (OCC complex)*	1
			DTS Console (100 LINES)	1
Stations		SCR	**Fixed Radio Terminal**	1
			DTS Console/Telephone (30 LINES)	1

1. List of Controllers in the OCC are indicative. Security Control can be located in separate room in OCC building. Actual requirements of controllers shall be developed by the contractor during design and submitted to the Engineer for review and consent.
2. Two numbers of additional Traffic Controllers are planned to be provided as part of phase-2 of WDFC. Table space for two additional positions as indicated in the drawing No. NKC-S&T-SD-AL-20016 shall be provided as part of phase-1.
3. One number of additional Traction Power Controller is planned to be provided as part of phase-2 of WDFC. Table space for one additional position as indicated in the drawing No. NKC-S&T-SSD-AL-20016 shall be provided as part of phase-1.
4. DTS extensions for each DTS console shall be developed during the design stage.

End of Appendix3

APPENDIX 4: CLOCK SCHEDULE

S. N.	Name of Station	Crew Changing	Station Control Room	Station Building other Offices	Service Building	IMD BUILDINGS	IMD - Sub Depot. Buildings			Total
							CIVIL	S&T	OHE & PSI	
		Digital	Digital	Digital	Digital	Digital	Digital	Digital	Digital	
1	**Rewari**	**2**	**1**	**6**	**6**	**7**				**22**
2	**Ateli**		**1**	**6**	6		2	2		17
3	Dabla		**1**	**3**	6		2	2		14
4	Bhagega		**1**	**3**	6		2	2		14
5	Shrimadhpur		**1**	**3**	**6**	7				17
6	Pachar Malikpur		**1**	**3**	6		2	2		14
7	**Phulera**		**1**	**6**	6					**13**
8	Sakun		**1**	**3**	6		2	2		14
9	Kishangarh		**1**	**3**	**6**		2	2		14
10	Sardana		**1**	**3**	6	7				17
11	Bangugram		**1**	**3**	6		2	2		14
12	Haripur		**1**	**3**	6		2	2	2	16
13	Chandaval		**1**	**3**	**6**		2	2		14
14	**Marwar**	**2**	**1**	**6**	6	**7**				**22**
15	Jwali		**1**	**3**	6		2	2		14
16	Biroliya		**1**	**3**	6		2	2		14
17	Keshavganj		**1**	**3**	**6**	7				17
18	Banas		**1**	**3**	6					10
19	Swarupganj		**1**	**3**	6		2	2	2	16
20	Siriamirgarh		**1**	**3**	6		2	2		14
21	Chadotar		**1**	**3**	1					5
22	**Palanpur**		**1**	**6**	**6**	**7**				20
23	Malosan		**1**	**3**	6		2			12
24	**Mehsana**		**1**	**6**	6				2	13
25	Ghumasan		**1**	**3**	6		2	2		14
26	**Sabarmati North**		**1**	**6**	**6**	**7**				20
27	**Sabarmati South**		**1**	**6**	6	**7**				20
28	Timba		**1**	**3**	6		2	2		14
29	Changa		**1**	**3**	6		2	2	2	16
30	Vasad		**1**	**3**	**6**		2	2		14
31	**Makarpura**	**2**	**1**	**6**	**6**	**7**				**22**
32	**OCC**		**10**							10
	Total									**487**

Requirements are based on the tentative building plans.
Contractor shall develop the matrix during design and submit to the Engineer for consent.

End of Appendix 4*

APPENDIX 5: CONTRACT SPARES

S.No	Item	Total Quantity
1	SDH Node complete with all tributary cards and full hardware redundancy	10% of the total population for Each type
2	2 Mb Mux complete with all channel cards and full hardware redundancy	10
3	All type of PCB cards including mother board ,Optical line termination Card,E1 Tributary card and power supply card for STM- Mux	10% of the total population for Each type for Phase I
4	All type of PCB cards including mother board ,2MB card ,VF card, E&M Card ,Data card and power supply card for 2 MB Mux	10% of the total population for Each type for Phase I
5	Laptop service terminals loaded with OFC NMS software	6
6	Dispatcher's Console 100 lines Complete for OCC	2
7	Dispatcher's Console 30 line Complete for SCR	4
8	DTS Telephone Instruments other than DTS consoles	10% of the total population for Each type for Phase I
9	Laptop loaded with EPABX NMS Software	4
10	Each type of module/card of EPABX system	10% of the total population for Each type for Phase I
11	Each type of Module/card including mother board for Dispatch telephone system	10% of the total population for Each type for Phase I
12	Digital Telephone Instruments	10% of the total population for Each type for Phase I
13	Analogue Telephone Instruments	10% of the total population for Each type for Phase I
14	Analogue Feature Telephone Instruments	10% of the total population for Each type for Phase I
15	All type of replaceable / plug-in modules for Centralised Voice recording System	10% of the total population for Each type for Phase I
16	Video Cameras complete with housing	5% of the total population for Each type for Phase I
17	Laptop loaded with Video Surveillance system software	1
18	Train Mobile Radio complete with MMI and accessories as per locomotive	10
19	GSM-R Radio Base Station Equipment complete	2
20	Field Replaceable modules/cards for BSS, NSS, OMC, NMC, SIMS	10% of the total population for Each type for Phase I
21	Handheld Portables (OPH)	10% of the total population for Each type
22	Handheld Portables (GPH)	10% of the total population for Each type
23	Radio Dispatcher's Workstation (RDW) for OCC	1
24	Fixed Radio Terminal for SCR	2

S.No	Item	Total Quantity
25	Hand Portable Battery Charger Unit	10% of the total population for Each type for Phase I
26	Train Mobile Radio Antenna	10% of the total population for Each type
27	Cards/modules for Radio MSC and all other units of radio system	10% of the total population for Each type (atleast one of each type)
28	Radio Base station antenna	5% of the total population for Each type
29	Notebook computer loaded with Radio NMS software	4
30	Cards/modules for SMPS Based Float Cum Boost Charger (48 V DC)	10% of the total population for Each type for Phase I
31	Maintenance Free Batteries	5% of the total population for Each type for Phase I
32	Replaceable / plug-in cards for Master Clock	1 card atleast each
33	Field Replaceable modules/cards for Sub Master Clock	10% of the total population for Each type
34	Sub-master clock complete	10% of the total population for Each type
35	Digital clock units	10% of the total population for Each type
36	Analogue Clocks	10% of the total population for Each type
37	Fuses of all types	Two (2) times the quantity in actual use
38	Fuse Bases	10% of the total population for Each type
39	Terminals of all types	5% of the total population for Each type for Phase I
40	Optical Distribution Frame	5% of the total population for Each type for Phase I
41	MDF	5% of the total population for Each type for Phase I
42	Copper Cable Jointing Kits for all sizes of cables	10% of the total population for Each type
43	Splicing Kits for OFC	10% of the total population for Each type
44	Optical Fiber Cable	10 km for each type
45	Optical Fiber Splice Box & remake loops	5% of the total population for Each type for Phase I
46	Optical pigtail cables	5% of the total population for Each type for Phase I
47	Outdoor Telephone Cable	10% of the total quantity used for Each type
48	Indoor Telephone Cable	10% of the total quantity used for Each type

S.No	Item	Total Quantity
49	Video & data Cables for video surveillance system	10% of the total quantity of each type used
50	Power Cable	1Km. of each type
51	Earthing cable	500 meter of each type
52	RF Cable	1Km. of each type
53	Complete set of cables for electric locomotive wiring for cab radio	5 sets
54	Cable for Clock system	1Km of each type
55	Data cables for Networking	1 Km of each type
56	All type of Connectors/Dummy Loads	10% of the total population for Each type for Phase I

∗ End of Appendix 5 ∗

APPENDIX 6: TOOLS AND TEST EQUIPMENT

S.No.	DESCRIPTION	MAKE	MODEL	Laboratory	Field Use	Total	Units
		Or Equivalent					
1	SDH Analyser			1	2	3	Nos.
2	Transmission Measuring set			1	2	3	Nos.
3	PCM Channel Analyser			1	2	3	Nos.
4	Optical Power Source			1	9	10	Nos.
5	Optical Power Meter			1	9	10	Nos.
6	Optical Talk Set			2	9	11	Nos.
7	OTDR Mini			1	18	19	Nos.
8	OTDR Main Frames			1	9	10	Nos.
9	Optical Adaptors, Directional Couplers, Test Cords, Patch Cords, etc.			1	9	10	sets
10	Optical Attenuator Set (including variable optical attenuator)			1	2	3	sets
11	Optical Fiber Tool Box			1	9	10	Nos.
12	Mechanical splices			4	42	46	Nos.
13	Auto Fusion Splicing Machine complete			2	18	20	Nos.
14	Pigtails			4	42	46	Nos.
15	Ethernet Analyser			1	2	3	Nos.
16	Radio Test Set covering all trans-receive parameters			1	9	10	Nos.
17	Spectrum Analyser (RF)			1	2	3	Nos.
18	RF Attenuator Set			1	2	3	Sets
19	RF Cables			2	18	20	Sets
20	RF Power Meter with Reference Attenuator, Sensors, etc.(portable)			2	9	11	Nos.
21	RF Signal Generator			1	2	3	Nos.
22	VSWR Meter with directional couplers, accessories, etc.			2	2	4	Nos.
23	Digital Exchange Test Set for comprehensive Test and Measurements on Digital Exchanges complete with all accessories			1	2	3	Nos.
24	Line Testing Equipment for Subscriber Lines and Telephone Sets			2	18	20	Nos.
25	Cable Fault Locator			2	18	20	Nos.
26	Cable route locator			2	18	20	Nos.
27	Cable Tool Kit			2	18	20	Nos.
28	Earth Testing Kit			1	9	10	Nos.
29	Insulation Testers (Meggar 500 Volts			1	9	10	Nos.
30	Mega Ohm meter			1	9	10	Nos.
31	Multimeter - Digital (Hand-held)			2	18	20	Nos.

S.No.	DESCRIPTION	MAKE	MODEL	Laboratory	Field Use	Total	Units
		Or Equivalent					
32	Multimeter - Digital (High-precision)			2	2	4	Nos.
33	Multimeter - Analog			2	18	20	Nos.
34	Power Supply (Variable) 0-60 Volts Dc			1	2	3	Nos.
35	Variac, Single-phase 240V AC (5 KVA)			1	2	3	Nos.
36	Oscilloscope (100 MHz) - Dual Trace (Storage)			1	-	1	Nos.
37	Soldering Iron (25W)			2	18	20	Nos.
38	Soldering Iron (50W)			2	18	20	Nos.
39	Solder Wire			1	9	10	Kg
40	Soldering Work Station (Temperature regulated)			2	2	4	Nos.
41	Spanner Set			2	18	20	Sets
42	Tool Kit (screw drivers, pliers, crimping tool, etc.)			2	18	20	Sets
43	Vacuum Cleaner			1	18	20	Nos.
44	Drilling Machine with hammer action capable of working on wood, metal, concrete complete with chuck drill bits			1	2	3	Nos.

End of Appendix 6

APPINDIX 7: SPECIFICATIONS OF PRE-FABRICATED TELECOM PORTA HUTS

1 **General:**

1.1 Contractor shall design, supply, install and commission prefabricated metal cabin type Telecommunication Equipment Huts, at locations other than stations & OCC, of adequate size complete with air-conditioning and furnishing for housing GSM-R radio Base Station equipment, SDH/ADM equipment, networking equipment, batteries, battery charging equipment and equipment for level crossing gate telephone etc; The design details of the Telecom Equipment Hut(s) shall be submitted to the Engineer for review as part of the detailed design for OFC system. The cabin huts shall be re-locatable type pre-furnished and prewired.

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.

2 Wall Construction.

2.1 External facing shall be of galvanized sectional sheet-metal of adequate thickness.

2.2 Adequate thermal insulation shall be provided by using mineral wool or rubber or fibre glass of adequate thickness.

2.3 Dismountable retaining consoles for mono-block air-conditioning unit and compact unit for room air-conditioning.

2.4 Air tight doors of adequate size to permit entry of largest equipment cabinet shall be provided. Doors shall have special security system on locks to prevent vandalism. Door opening alarm shall be provided in the SCR of nearest station and/ or in OCC as decided by the Engineer.

2.5 Contractor shall propose the equipment layout plan inside the cabin for effective temperature management for the equipment.

3 **Roof Construction**

3.1 The roof shall be protected from sun heat with adequate thermal insulation.

3.2 Clear height inside the cabin shall be sufficient for installation of equipment, cable/wiring trays and provision of tube lights etc.

3.3 Panel Air-Conditioning system shall be installed.

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 of adequate thickness.

4.2 It shall be made waterproof with bonded hardboard plates.

4.3 Good thermal insulation shall be achieved using mineral wool/rock wool/rubber/fibre glass or any other equivalent suitable material of adequate thickness. The finished cabin shall provide adequate acoustic and radio signal insulation.

4.4 Floor openings for cables as needed shall be provided. The openings shall be sealed after installation of cables.

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/m2, 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 Electrical Installation:

7.1 Space for Auto change over switch and termination of AT supply from UP & DN Catenary to be provided. Auto change over switch with termination from UP & DN catenary shall be carried out by EM P-4 contractor.

7.2 Internal electrical wiring & fixtures for light, power socket etc. shall be provided by the ST P-5 contractor.

8 **Foundation:**

8.1 Provision of concrete foundations including earth work, if necessary, to be done.

8.2 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 Fire Protection

10.1 Portable fire extinguisher(s) of adequate capacity, specifications and suitable for electrical and electronic equipment shall be provided by the contractor in each telecom porta hut.

11 Air Conditioning

11.1 Panel Air Conditioning shall be provided to regulate temperature of installed equipment inside all the prefabricated structures within limits so as to facilitate proper working of electronic equipment and VRLA battery as otherwise summer time temperature inside the equipment room is likely to reach very high levels. At no time temperature inside prefabricated huts shall be allowed to go beyond 27 degree Celsius. A suitable plan to this effect shall be submitted to the Engineer for his consent as part of the Preliminary Design.

12 The entire design shall be pilferage proof.

End of Appendix 7

APPENDIX 8 : CONTRACTOR'S COORDINATION WITH OTHERS (INTERFACE MANAGEMENT)

8 General

The Contractor (ST P-5 Contractor) shall interface with Other Contractors (Contractors of CT P-1, CT P-2, CT P-3, CT P-3A, EM P-4 and RS P-7 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.

8.1. Contractor's Responsibility

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

8.1.2 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.

8.2. 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)	Appendix	9-1	EM P-4/ST P-5 (Specific Issues)
(ii)	Appendix	9-2	ST P-5 /RS P-7 (Specific Issues)
(iii)	Appendix	9-3	EM P- ST P-5 /CT P-1, CT P-2, CT P-3, and CT P-3A (Specific Issues)
(iv)	Appendix	9-4	ST P-5 /Indian Railways (Specific Issues)
(v)	Appendix	9-5	ST P-5 /ST P-17 (Specific Issues)

8.3. General Definitions and Scope

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

8.3.2 This is common to all the interfacing contracts.

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

8.3.4 In the event of a conflict between the Particular Specification and the Appendices as listed above, the requirements of the Particular Specification shall prevail.

8.3.5 "Project Wide" for the purpose of the Appendices is defined as the complete Scope of Work to be executed under Contracts CT P-1, CT P-2, CT P-3, CT P-3A, EM P-4, ST P-5 and RS

P-7 including other obligations of the Employer for successful commissioning of DFC Western Corridor Phase1 .

8.3.6 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.

8.3.7 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.

8.4. Contractors' Responsibilities

8.4.1. 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 1). 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.

8.4.2. The contractors (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.

8.5. Physical interface issues – General

8.5.1 Contractors' Responsibilities

8.5.1.1 EM P-4 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.

8.5.1.2 The EM P-4 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.

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

8.5.1.4 The EM P-4 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

8.5.1.5 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

8.5.1.6 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.

8.5.1.7 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.

8.6. ELECTRICAL & PHYSICAL INTERFACE

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

8.6.1.1 The Project Wide EMC/EMI Management Plan shall fully detail the approach and processes to manage EMC across all the Works required for Design, Construct, Commission, Test, Operate and Maintain 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 EM P-4 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).

8.6.1.2 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.

8.6.1.3 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 Engineer for his consent.

8.6.1.4 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 EM P-4 Contractor.

8.7. Earthing & Bonding

8.7.1 EM P-4 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.

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

8.7.3 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 EM P-4 Contract as per the agreed programme.

8.7.4 The Interface Coordinator of EM P-4 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.

8.7.5 The Interface Coordinator of EM P-4 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.

8.7.6 Agreed Earthing and Bonding drawings shall be signed jointly by EM P-4 and ST P-5 contractors.

8.8. ANTI THEFT CHARGING OF OHE

8.8.1 As an anti-theft measure, the OHE after erection may be charged at 2.2 kV by EM P-4 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 on antitheft measure.
- 24 hour monitoring of the section and its patrolling.
- Permission of E.I.G.
- DOT (Department Of Telecom) clearance

8.8.2 EM P-4 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.

8.8.3 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.

8.8.4 Detailed procedures and rules shall be prepared by the Contractor and submitted to the

Engineer for his consent & issue to all the concerned.

8.9. Systems Integration Requirements

8.9.1 The EM P-4 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.

8.9.2 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 EM P-4 Contract.

8.9.3 The EM P-4 Contractor shall integrate all the contractor's system integration strategies into a single document with all interfaces agreed.

8.9.4 Prior to commissioning of any system, the ST P-5 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

8.9.5 All the contractors shall prepare Systems Integrated Testing Plan and submit the same to Engineer for his consent and approval of the Employer. The Interface Coordinator of EM P-4 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 instrumented 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.

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

8.9.7 The ST P-5 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.

8.9.8 The contractors shall immediately notify the Engineer and Interface Coordination Manager of EM P-4 Contract of test failures, if any.

8.9.9 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.

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

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

* * * End of Appendix 8 * * *

APPENDIX 9-1: PHYSICAL INTERFACE BETWEEN EM P-4 & ST P-5 – SPECIFIC ISSUES

1. INTRODUCTION

1.1 Definitions and Scope

1.1.1 This Appendix covers the interface requirements between ST P-5 Contractor and EM P-4 Contractor.

1.1.2 This appendix forms a part of both the ST P-5 and EM P-4 General Specifications. In this appendix, unless otherwise stated, the term “Contracts” refers to both the ST P-5 and EM P-4 contracts and the term “Contractors” refers to both the ST P-5 and EM P-4 Contractors. The individual Contractor is referred to by the corresponding contract number.

2. Contractors’ Responsibilities

2.1 The ST P-5 contractor shall provide the EM P-4 Contractor with the signal scale plan, showing the proposed locations of signal posts, Axle Counter Track section boundaries, Auto Location and Telecom Huts.

2.2 The EM P-4 Contractor shall provide the ST P-5 contractor with the location and numbering of all OHE masts, TSS, SP, SSP and ATS.

2.3 The ST P-5 contractor shall work with the EM P-4 Contractor so that signals are 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.

2.4 The contractors shall co-ordinate for ensuring the 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.

2.5 The ST P-5 contractor shall provide the EM P-4 Contractor with the locations of the signals and co-ordinate with the EM P-4 Contractor to decide on final locations. The staggering of OHE masts ahead of the signals shall be in accordance with ACTM. The ST P-5 Contractor shall supply and install all necessary brackets and fixing material for installing signals.

3. ELECTRICAL INTERFACE

3.1 General:

3.1.1 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.

3.2 Traction Return

3.2.1 The ST P-5 Contractor shall advise the EM P-4 Contractor of the location of the Axle Counter Track Devices required by the Train Control and Signalling system.

3.2.2 P-4 contractor shall prepare 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. Both the contractors shall agree on the final location of these bonds.

3.2.3 EMP-4 Contractor shall advise the locations of all Auto Transformers on the line where Impedance Bonds for Rail Connectors will be compulsorily required. These locations shall be at all TSS, SP,SSP and at all other AT locations.

3.2.4 The EM P-4 Contractor shall supply, install and terminate bonding cables.

3.2.5 For connecting the return current cables from the auto transformers and at TSSs to the running rails, EM P-4 Contractor shall co-ordinate with ST P-5 contractor. The terminations of cables shall be agreed by both the contractors.

3.2.6 EM P-4Contractor shall co-ordinate with ST P-5 Contractor to determine the actual locations of cross bonding cable connections. The length of cross-bonds shall be kept as short as possible.

3.3 SCADA Requirements

3.3.1 EM P-4 Contractor shall work out during initial stages of the Contract, location by location, SCADA requirements and furnish, the requirements of the data bandwidth from each location to OCC, to ST P-5 Contractor.

3.3.2 The ST P-5 Contractor shall lay redundant Optical Fiber cables to each of the locations of TSS, SSP, SP and ATS from the nearest TER at stations or the nearest Telecom (porta) Hut.

3.3.3 EM P-4/CTP-1, 2, 3 shall provide space required for termination of OFC cable(s) in the control building or Kiosk provided by EM P-4 at TSS, SP, SSP, and ATS locations, stations, IMD.

3.3.4 Required number of OFC fibers between the TSS/SP/SSP/ATS and TER/Telecom Hut shall be made available to EM P-4 by ST P-5. Connections of OFC fibers to SCADA equipment at RTU end shall be the responsibility of EM P-4 while at the TER end it will be that of ST P-5. Data of SCADA shall be further extended from TER/Porta Hut to OCC by ST P-5 contractor.

3.3.5 The location of TSSs, SPs, SSPs and ATSs can be estimated from drawing Nos. EMP4/PS/200 and EMP4/PS/201 Volume V. ST P-5 contractor shall provide the necessary channels/bandwidth as required.

3.3.6 EM P-4 Contractor shall provide requirement of video wall for Phase-I and Phase-II sections for OCC to ST P-5 Contractor. ST P-5 Contractor shall procure and install video wall at OCC and shall make available power supply from PSS (S&T) for both train control and Traction Video Wall.

3.3.7 EM P-4 Contractor shall provide data feed to video wall controller for the Project.

3.3.8 VDU terminal for SCADA shall be provided by EM P-4 Contractor for the Project.

3.3.9 EM P-4 and ST P-5 Contractors shall provide the contractor responsible for construction of OCC building with the requirements for space in OCC control rooms and for their equipment including furniture, server room and training room.

3.3.10 EM P-4 Contractor shall obtain time synchronization signal from ST P-5 Contractor for SCADA application throughout the system.

3.4 AT Supply

3.4.1 ST P-5 Contractor shall furnish to EM P-4 Contractor the details of Auto Location Huts and Telecom Huts being provided in Block Sections along with load requirement.

3.4.2 EM P-4 Contractor shall provide 230 V Single Phase AT supply tapped from both Up and Dn OHE with automatic Changeover.

3.4.3 ST P-5 contractor shall provide space inside Auto Location and Telecom Huts for fixing Automatic changeover panel by EM P-4 Contractor.

3.4.4 LT Cable from Auxiliary Transformers to Auto Location and Telecom Huts shall be provided and laid by EM P-4 Contractor.

3.4.5 ST P-5 Contractor shall provide his own cable at the output of Automatic Changeover panel.

4. Location of Neutral Section

4.1 The EM P-4 Contractor shall provide the ST P-5 Contractor with the location of all neutral sections in order to ensure that location of STOP signals are adjusted to ensure coasting of locomotive while negotiating neutral section.

4.2 The ST P-5 Contractor shall design the signalling system such that no locomotive or a part of a locomotive stops within the neutral sections during normal operations.

5. SCOPE OF SUPPLY

5.1 Scope of the ST P-5 Contract

5.1.1 ST P-5 Contractor shall provide all telephones at OCC and TSS etc.

5.1.2 ST P-5 Contractor shall provide OFC data/fiber connectivity between OCC and TSS, SSP, SP and ATS. EM P-4 Contractor shall interface his equipment with the data ports at OCC and OFC cable fibers at TSS, SSP, SP and ATS.

5.1.3 The ST P-5 Contractor shall specify the requirements for termination of OFC Cables at TSS, SP, SSP and ATS locations. These requirements shall be integrated into the control building or kiosk by the EM P-4 Contractor.

5.1.4 The ST P-5 Contractor shall provide and install all equipment necessary, except RTUs etc at TSS, SP, SSP and ATSs, to ensure correct operation of the train detection system in respect of system requirements of EM P-4 Contractor.

5.2 Scope of the EM P-4 Contract

5.2.1 The EM P-4 Contractor shall supply, install and terminate bonding cables from rail to earth and from rail to rail including the provision of earth & necessary accessories for fixing and terminating the bonding cables.

5.2.2 The EM P-4 Contractor shall provide physical details of the OHE masts and their locations including GPS mapping of all the masts and clearly indicate OHE mast location number with corresponding co-ordinates.

5.2.3 EM P-4 Contractor shall provide housing for telecom equipment at TSS, SSP, SP and ATS.

5.2.4 EM P-4 Contractor shall provide AT supply from Up &Dn OHEs with Automatic changeover panels.

5.2.5 EM P-4 Contractor shall provide RTUs and all other equipment at TSS, SP, SSP and ATS end as may be required for SCADA.

6. TELEPHONES AND RADIOS

6.1 ST P-5 and EM P-4 Contractors shall co-ordinate for the provision and location of telephones at OCC and TSS etc.

6.2 The EM P-4 Contractor shall provide requirements & specification to ST P-5 contractor stating the requirements for telephones at above locations. In particular, special attention shall be paid to the requirements for OCC. Requirements for call waiting, prioritization and handling emergency calls shall be clearly specified.

6.3 EM P-4 Contractor shall provide requirements to ST P-5 Contractor for radio communications.

6.4 ST P-5 Contractor shall provide all radio systems.

* * * End of Appendix 9-1 *** * ***

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APPENDIX 9-2: PHYSICAL INTERFACE BETWEEN RS P-7& ST P-5 – SPECIFIC ISSUES

1. INTERFACES

Interfaces between RS P-7 and ST P-5 Contracts shall include but shall not be limited to the items included in interface matrix below

Appendix '9-2' Cont.

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
1	Earth Work in depot and construction of access Road to depot.	Furnish details of formation level at Ch. 14.449 (main entry / exit point of the ELMD) and at Ch. 15.320 (emergency entry / exit of ELMD) and on either side of the depot for tracks leading towards Dadri and Hisar and also the connecting line between the two.	x	x	1. Design and Build earth work for track formation a) From Ch. 14.449 (main entry / exit point of the ELMD) to inside the ELMD area such that formation level inside the ELMD area shall be not less than 100mm above the formation level at Ch. 14.449. b) From ELMD to the Ch. 15.320for emergency entry / exit of ELMD 2. Design and Build of the Access Road to ELMD shall be constructed by RS P-7 Contractor.
2	Construction of cable trough and trenches including pull pits	x	x	x	Shall Design and construct all power cable troughs, trenches inside the depot for HV, LV, 25kV, communication and signalling cables.
3	Construction of Fencing boundary wall and gate.	xx		xx	Design and construct boundary wall, fencing and entry gates including earthing if required.
4	Design and Track Layout	Provide information on	Shall provide location of OHE masts and	xx	Design and construct track a) from Ch. 14.449 (main entry / exit point of

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
		Rewari Yard and main line formation level track design details and construct track upto Depot entry at Ch. 14.449	foundation details clear of the track alignment near Ch. 14.449 (main entry / exit point of the ELMD) and at Ch. - 15.320 (emergency entry / exit of ELMD)		the ELMD) to the entire ELMD area. b) From ELMD to Ch. 15.320 (emergency entry / exit of ELMD)
5	Construction of OHE from Ch. 14.449 to the entire depot	xx	Will install OHE upto Ch. 14.449 (i.e. up to main entry / exit point of the ELMD) and up to Ch. 15.320 where the emergency entry / exit of ELMD meets the Mail Line and suitably anchor. Also furnish information on vendors of OHE fitting & conductors etc. to RS P-7.		Design and build OHE from Ch. 14.449 to the entire shed and upto the connection of emergency entry / exit of the ELMD with the DFC Main Line at Ch. 15.320 including proper sectioning and earthing system for safety and ease of operation. Install section insulators. and interruptors to isolate various areas of the ELMD, so that any fault inside depot, main line power supply does not affect Depot working. All the OHE fittings etc. shall be obtained from vendors approved for EM P-4 Contractor.
		xx	Shall provide SSP at boundary of the Depot and provide circuit breakers for the depot 25kV feeds to the depot. Shall interface with RS P-7 for flow of traction return current		The circuit breakers at the Depot SSP shall be controllable on SCADA from OCC and BCC. He shall also ensure flow of traction return current especially from inspection bays and workshop areas back to traction sub-station.

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
			back to sub-station.		
6, 7 & 8	Items of work relating to Signalling and interlocking system	Refer to Section 9 Particular Specifications Part 1			
9(a)	On-board radio and train radio antenna			Shall supply on-board radio equipment and train radio antenna to the RS P-7 Contractor's Works	Shall provide space in the electric locomotive design for fixing and installation of on-board radio equipment and train radio antenna at the manufacturer's facility, by the RS P-7 Contractor, under the supervision of the ST P-5 Contractor for the first locomotive. For further locomotives subsequently to be carried out by RS P-7 Contractor as per instructions/Procedure Manual provided by ST P-5
9(b)	On-board radio power supply requirements			Furnish load values at 110 VDC, and environmental requirements for the on-board radio equipment and earthing requirements to RS P-7 Contractor.	To provide the required load /voltages and earthing.
9(c)	On board radio lines between front and rear cabs of locomotive			Requirement of data links/lines between front and rear cabs to be given by ST P-5	shall provide required data links/lines between front and rear cabs of the locomotive for highly reliable fault tolerant system functioning of radio.
9(d)	On-board radio environmental requirements – air-conditioning			shall specify at an early date, the total heat load wattage, and maximum permitted temperature	shall provide Cab Air Conditioning installation.

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
9(e)	On board radio EMC/EMI requirements			shall advise EMI/EMC plan for radio equipment to RS P-7 Contractor at early date.	shall ensure the compliance of the requirements of ST P-5 Contractor for on board radio equipment installation.
9(f)	Radio Dispatch Workstation (RDW) installation in DCC/ELMD			Required data channel(s) of the OFC communication system from OCC/Rewari to ELMD shall be made available at WDFC system end for connections of the RDW of DCC to the central equipment in OCC. Will configure and programme RDW of DCC for functionalities as per PS and associate in the testing.	Will procure RDW and associated accessories from the same vender as by ST P-5 for WDFC, install in the DCC. Data channel(s) will be connected to the RDW at ELMD end and tested for the functionalities per PS.
9(g)	Radio system procurement and commissioning of Handportable radios	xxx	xxx	OPH /Shunting hand portables of ELMD will be powered up as required for registration and configuration etc. as per PS.	Will procure OPH /Shunting hand portables for requirement of ELMD. Power up OPH /Shunting hand portables as required for registration and configuration etc. as per PS.
9(h)	Diagnostic data transmission from loco to DCC/OCC and radio communication traffic			i) will include, in the traffic calculations, the requirements of locomotive	Identify the diagnostic data from Electric locomotive which needs to be transmitted to the DCC. Shall design the Interface and submit to the Engineer for review and approval. To limit

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
	calculations			diagnostic data transmission from the locomotive while on the WDFC main line to the DCC. Will perform programme/ configuration as required in the MSC at OCC	excessive loading of the radio channels a reasonable interval for transmission of data jointly agreed with ST P-5 shall be proposed in the interface design and submitted to the Engineer for notice of NO Objection. Shall implement the physical interface between the locomotive equipment and the radio equipment
9(i)	Radio Frequency signal coverage within ELMD area			Design the WDFC GSM® system and provide signal strength coverage in ELMD area and WDFC as per PS and test jointly with RS P-7 the RF signal strength within the ELMD	Will participate in the measurements and record the results.
10(a)	OFC Communication – Fiber Optic cables between TERs of Rewari station and ELMD			i) Furnish cable duct/cable tray requirement within the ELMD portion. ii) Furnish requirement of space for installation of ODF in the TER at ELMD iii) Lay OFC cable & terminate in TER. iv) Provide the required	i) Incorporate routing of outdoor Cable Ducts and construct the same for laying of OFC cable. ii) Indicate requirement of fibers

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
				fibers to RS P-7.	
10(b)	OFC Communication SDH node equipment			**i)** Provide the design architecture for the SDH ring including node of ELMD. ii) Integrate ELMD node in the SDH network. Coordinate and provide required channels at the WDFC end.	I) Procure and Install the SDH equipment, from same vendor as of ST P-5, at ELMD as per design given by ST P-5 Furnish requirement of voice and data channels from ELMD to other locations of WDFC
10(c)	OFC Communication – Networking	xx	xx	Required data channels of the OFC system shall be made available at WDFC end. Interface requirements shall be implemented and tested	Will install LAN for requirements of the ELMD. Interface with ST P-5 to link it to the WAN of the WDFC and test.
11	PABX Telephone system	xx	xx	i) Requirements of the data channels of OFC communication system for integration of the PABX of ELMD with PABX network of WDFC shall be determined during detailed design. ii) Required data	i) PABX for ELMD shall be procured and installed by RS P-7 contractor. ii) Design for integration of the ELMD PABX with PABXs of WDFC shall be agreed with ST P-5 and submitted to the Engineer for notice of NO Objection iii) All connections required at ELMD end for integration of the ELMD PABX with the WDFC PABX system shall be done by RS P-7 contractor. iv) Jointly test the integration of PABX system.

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
				channel(s) of the OFC communication system from OCC/Rewari to ELMD shall be made available at WDFC system end for integration of the ELMD PABX to the PABX network of WDFC. iii) Jointly test the integration of PABX system.	
12	Dispatch Telephone System (DTS)			i) Shall determine, during detailed design stage, the requirements of the data channels of OFC communication system for integration of the Dispatch telephone system of ELMD with that of WDFC. ii) Will make available the required data channel(s) at WDFC system end	i) Dispatch Telephone system for ELMD shall be procured and installed by RS P-7 contractor. ii) Design for integration of the ELMD DTS with DTS of WDFC shall be agreed with ST P-5 and submitted to the Engineer for notice of NO Objection iii) All connections required at ELMD end for integration of the ELMD DTS with the WDFC DTS shall be done by RS P-7 contractor. iv) Jointly test the integration of DTS.

INDICATIVE INTERFACE MATRIX FOR DEPOT DESIGN AND BUILD CONTRACTOR AND OTHER DESIGNATED CONTRACTORS					
S.No.	**ITEM OF WORK**	**CTP- 1**	**EM P-4**	**ST P-5**	**RS P-7**
				and integrate the ELMD dispatch telephone system with the WDFC system at OCC/Rewari as determined during design. Jointly test the integration of the DTS.	
13	Clock System			i) Interface design for synchronization of Sub master clock and other sub systems of ELMD with the Master clock of OCC will be jointly worked out with RS P-7 contractor and submitted to the Engineer for notice of NO Objection. Associate in joint testing of interface.	i) Sub Master Clocks and display clocks for ELMD shall be procured and installed by RS P-7 contractor. ii) The sub-master clock of ELMD shall be synchronised with the Master clock of WDFC at OCC as per the approved interface design Jointly test the interface.
14				Furnish information of vendors of telecom equipment to RS P-7 contractor	All the telecom equipment shall preferably be procured from vendors approved for ST P-5 Contract..

* * * End of Appendix 9-2 **

APPENDIX 9-3: PHYSICAL INTERFACE ISSUES BETWEEN ST P-5 & Civil works contractors

CT P-1 Civil/Building/Track Works Rewari – Ajmer Section;
CT P-2 Civil/Building/Track Works Ajmer –Ikbalgarh Section;
CT P-3 Civil/Building/Track Works Ikbalgarh – Vadodara Section (excluding bridges across river Mahi and Sabarmati);
CT P-3A Steel Bridges across rivers Mahi and Sabarmati;
hereinafter referred to as 'Civil Works Contractors'

1. Definitions and Scope

1.1 This Appendix shall be read in conjunction with the relevant clauses of the Particular Specification. Both the ST P-5 Contractor and Civil/Building/Track Works/Special Steel Bridge Contractors shall be responsible for ensuring that all requirements of the GS pertaining to interfaces are properly satisfied.

1.2 Notwithstanding the requirements described elsewhere in the Contract regarding the precedence of documents, the provisions contained in the Particular Specifications and Reference Drawings shall prevail over the provisions contained in this Interface Specification.

1.3 This Appendix outlines Interface requirements during the execution of the Works. However, the requirements herein specified are only indicative and it remains the responsibility of ST P-5 and Civil Works Contractors to develop, update and execute jointly an Interface Management Plan during the currency of the respective Contracts to ensure that.

(1) all interface issues between Civil/Building/Track Works/Special Steel Bridge Contractors and the ST P-5 Contractor are satisfactorily identified and resolved;

(2) All construction tolerances at the interface shall meet the requirements of the respective specifications.

2. The ST P-5 Contractor's Scope of Works

2.1 Where details of the ST P-5 Contractor's design are required to enable the Civil Works Contractors to implement the interface works, the ST P-5 Contractor shall provide the Civil Works Contractors with the necessary information. The level of information provided shall be of sufficient detail to enable the Civil Works Contractors to construct the interface works required.

2.2 The ST P-5 Contractor shall take a lead in developing the System Interface Management Plan in conjunction with the Civil Works Contractors to cover all aspects of the implementation of the interface works in this Appendix and all other interface works required to complete all works in the ST P-5 contract, including but not limited to those listed in clause 4 herein below.

2.3 The ST P-5 Contractor shall liaise with Civil Works Contractors during the development of the Interface Management Plan for any requirements of the Works.

3. Civil Contractors' Scope of Works

3.1 The Civil Works Contractors shall liaise with the ST P-5 Contractor in the detailed design, installation, testing and acceptance of the civil works provisions provided for the installation of various systems by the ST P-5 Contractor.

3.2 The Civil Works Contractors shall provide all access and attendance necessary in accordance with the General Specification to enable the ST P-5 Contractor to complete those activities defined under clause 4 of this Appendix in a timely manner. Such access and attendance shall include, but not be limited to, the safety supervision if necessary, safe access and egress to all

parts of the Works required to complete the survey and marking out Works. The Civil Works Contractors shall also provide competent personnel to witness and assist with the marking out activities and enable ST P-5 to use the main survey control data efficiently.

3.3 Civil works contractors shall furnish results of geotechnical survey to ST-P-5 Contractor, if required, for ensuring suitable & safe foundations for Auto Location Huts and Telecom Huts.

3.4 Where Civil Works Contractor's non-conformances are identified which shall impact on the ST P-5 Contractor's interface, the Civil Works Contractors shall submit the proposed remedial measures to the Engineer for review and shall copy the same to the ST P-5 Contractor.

4. Functional Interface

4.1 The ST P-5 Contractor shall work with CT P-1, CT P-2, CT P-3 and CT P-3A Contractors to obtain a continuous Track layout plan starting at the Delhi end of CT P-1 through to the Mumbai end of CT P-3. All Contractors shall co-operate to obtain plan. This plan shall be used for common project working chainages for all contractors. CT P-1, CT P-2, CT P-3, CT P-3A, EM P-4 and RS P-7 Contractors shall liaise with ST P-5 contractor for suitable access dates for taking up & completing Signal & telecom construction works to enable continuous progress of works without any hold ups.

4.2 Other contractors (Civil and Track) are required to standardize the layer naming in the Civil Works Drawings and numbering convention so as to allot layer numbers in the CAD layering as referred to in ER GS Appendix 8, para 3.7 to ST P-5 and other remaining contractors such as EM P-4 so as to make the layout plans pertaining to their discipline of work on the allotted layer. The ST P-5Contractor shall use the same CAD File on his allotted layer to develop his Construction Drawings.

4.3 ST-P-5 Contractor shall liaise with Civil works Contractors for provision of space for digging trench along both UP and DN lines in block section and for laying ducts in station areas for laying signalling Telecom cables such as OFC, telephone and other data and power cables. Ducts shall be supplied and laid by ST-P-5 Contractor.

4.4 ST-P-5 Contractor shall liaise with Civil works Contractors for alignment of storm drains along the track to ensure that the alignment of Cable ducts/trenches and storm drains do not obstruct each other.

4.5 ST-P-5 Contractor shall liaise with the Civil Works Contractors for drilling of holes in rails for fixing Axle Counter track devices. Holes shall be drilled by ST-P-5 Contractor.

4.6 Civil Works Contractors shall provide and lay 100mm dia Double wall corrugated HDPE pipes under the track for the following and at the locations as decided by ST P-5 contractor:

(i) Track crossing of cables at 50 locations per station considering Home to Home signal as station area and at 4 locations per Km in Block Sections;

(ii) Platform crossing at from Relay Room to track side at 2 locations per station;

(iii) Road crossing at 2 locations per Level Crossing.\

4.7 The buildings for Signal and Telecom equipment rooms, PSS(S&T) rooms and maintenance depots shall be constructed by the Civil Works Contractors. ST P-5 Contractor shall provide necessary details to finalise the layout of these structures. Floor loading details shall also be

furnished by ST P-5 Contractor to the Civil Works Contractors before the construction of respective buildings is taken up by them.

4.8 Civil Contractors shall make available their main Earth Bus in the station building and ST P-5 contractor shall extend it to his equipment rooms.

4.9 ST P-5 contractor shall give station wise electrical load requirements of his equipment at input of PSS(S&T) and Battery Backup system to concerned Civil Works Contractors.

4.10 ST P-5 contractor shall give his requirement of cable ducts on PSC/RCC bridges and viaducts to Civil Works Contractors.

4.11 ST P-5 contractor shall give his requirement of cable channels in floor and cable entry holes in walls of Signal and Telecom equipment rooms, PSS(S&T) room and ASM/panel room to Civil Works Contractors.

4.12 Civil Works Contractors shall provide necessary cable entry holes in walls and cable channels with removable Aluminium checked plate covers in floor of Signal and Telecom equipment rooms, UPSS(S&T) room and ASM/panel room.

4.13 ST P-5 contractor shall give his requirement for fixing cable channels on steel bridges to concerned Civil Works Contractors. Cable channels and its fixing arrangements shall be supplied and installed by ST P-5 contractor.

4.14 Civil Works Contractors shall furnish design of track formation, cess, track separation on main line and yards for erection of signal posts, location boxes etc. by ST P-5 contractor.

4.15 Civil Works Contractors shall prepare Coordinated Construction Programme in association with ST P-5 Contractor and shall provide the section wise dates to EM P-4 ST P-5 Contractor as to when the access to different sections shall be made available for carrying out his activities.

4.16 ST P-5 Contractor shall arrange provision of Signalling & Telecom equipment as per access dates to different stations & sections as provided by Civil Works Contractors.

4.17 Civil Works Contractors shall liaise with ST P-5 Contractor & the Engineer / Employer for identifying the land required for Auto Location and Telecom huts within the ROW and shall provide the access dates for the same.

4.18 ST P-5 Contractor shall arrange for construction of Auto Location and Telecom huts including erection of equipment at the above locations as per the access dates for the availability of identified land to be provided by Civil Works Contractors.

4.19 Civil Works Contractors shall liaise with ST P-5 Contractor to decide height of false ceiling and location of Air Conditioning ducts in Signal and Telecom equipment rooms and PSS(S&T) room so that there is no hindrance to fixing of equipment racks.

4.20 Civil Works Contractors shall hand over Points and Crossings fit for interlocking as per provisions of IRPWM and Signal Engineering Manual.

4.21 ST P-5 contractor shall give his requirement for provision of long sleepers for fixing point machines to concerned Civil Works Contractors.

4.22 Civil Works Contractors shall provide additional earth work above slope section on the embankment or by the side of the track in coordination with ST P-5 Contractor for provision of Location Boxes, Telecom Huts and Auto Location Huts.

4.23 ST P-5 Contractor shall give details of signalling and Telecom equipment dead load on bridges (cables, signal posts etc.) to concerned Civil Works Contractors.

* * * End of Appendix 9-3 *** * ***

APPENDIX 9-4: INTERFACE ISSUES BETWEEN INDIAN RAILWAYS &ST P-5

1. Definition and Scope

1.1 This Appendix describes the interface requirements between ST P-5 Contractor and Indian Railways (IR).

1.2 All interface shall be through the Employer.

1.3 Throughout this Appendix, 'the Contractor' shall mean the ST P-5 Contractor, whereas 'the

1.4 Contract' shall mean Contract ST P-5.

1.5 The interface issues between the Contractor and Indian Railways shall have to be identified. Such issues arise primarily at the following interfaces:

- The Signalling arrangement on interconnection line at junction stations;
- Level crossing working where it serves both Indian Railways and WDFC lines running side by side;

1.6 The scope shall comprise of but not limited to the following:

- Control and indications for signalling between WDFC and IR junction stations;
- Protection of existing cables and other gears of Indian Railways while carrying out works on WDFC;
- Control and indications for Level crossing working where it serves both Indian Railways and WDFC lines running side by side;
- Provide EPABX and Dispatch telephones at IR stations as per PS.
- Provide GSM R coverage and hand portable mobile instruments for use by IR station (Junction with WDFC Junction station) staff per PS.
- Earthing & Bonding;
- Signage;
- EMC/EMI;
- Integration testing;
- Exchange of data of train runs between WDFC and IR for Freight Operations Information System (FOIS) of IR.
- Provision of TMS terminals at required locations of IR to enable crew management at Junction stations;

2. Communications

2.1 All communication between the Contractor and Indian Railways shall be via the Employer as per 1.2 above.

* * * End of Appendix 9-4 *** * ***

APPENDIX 9-5: INTERFACE ISSUES BETWEEN ST P-17 & ST P-5

1. Definition and Scope

1.1 This Appendix describes the interface requirements between ST P-5 Contractor and Phase 2 Signal & Telecom contractor i.e. ST P-17.

1.2 All interface shall be through the Employer.

1.3 Throughout this Appendix, 'the Contractor' shall mean the ST P-5 Contractor, whereas 'the Contract' shall mean Contract ST P-5.

1.4 The interface issues between the Contractor and ST P-17 shall have to be identified. Such issues arise primarily at the following interfaces:

- The Signalling arrangement on interconnection at stations where boundaries of phase 1 and 2 meet;
- TMS provision for Phase 2.

1.5 The scope shall comprise of but not limited to the following:

- Control and indications for signalling at stations where boundaries of phase 1 and 2 meet;
- Control and indications for signalling in Block sections next to stations where boundaries of phase 1 and 2 meet;
- Provision of TMS equipment at stations, Auto Location Huts, IMDs etc. of Phase 2;
- Updating of software in TMS servers in OCC so as to cover Phase 2 works for all prescribed functionalities;
- Earthing & Bonding;
- Signage;
- EMC/EMI;
- Integration testing;
- Provision of data of train runs from WDFC to IR for Freight Operations Information System (FOIS) of IR at Junction stations of Phase 2.
- Provision of TMS terminals at required locations of IR to enable crew management at Junction stations of Phase 2;
- Telephone / Radio arrangement between IR and WDFC of Phase 2.
- Providing OFC fibers of main OFC cable (24 fiber cable) for extending all systems of Phase 2 to OCC and adjoining stations.
- Providing on phase 1 adequate number of E1s and other data rate circuits including at least one number of ADM1for cross connection with the Phase 2 OFC communication system.
- Facility of extending Master clock of phase 1 from OCC to meet with the requirements of clocks and synchronisation of phase 2 systems.
- Facilities for integration of GSM(R) of phase 2 with the MSC etc of phase 1.
- Facilities of integration of PABX and Dispatch telephone systems of phase 1 with those of phase 2.

* * * End of Appendix 9-5 *** * ***