

EMPLOYER's REQUIREMENTS

GENERAL INFORMATION

1. GENERAL

- 1.1 Pakistan Railway's intends to rehabilitate and modernize its existing signaling system at Sarhad Station with the Computer Based Interlocking (CBI) and Semi-Automatic / Absolute Block system between the adjacent stations.
- 1.2 Sketch of the yard layout for above station has been included as Annexure-W at the end of the technical aspects. The plan is only for the guidance of bidders and they shall carry out detailed survey to physically ascertain the data and field condition. The yard layout may slightly vary during actual execution of work. Accordingly, any variations from this yard layout regarding addition/deletion of any line/point etc. shall be adjusted during execution of the contract agreement on the basis of quoted rates.
- 1.3 The bidders shall be responsible to construct, design, manufacture, supply, install and commission the system in all respects. Railways shall, however be responsible for providing support as specified in item 7 of this Chapter. Any and all other tasks/assignments/jobs will be done by the bidders to complete the project in all respects according to international standards whether mentioned or not in the specifications.
- 1.4 Only the Firms/Manufacturers, proven track record in railway signaling and related infrastructure projects, both locally and internationally. Interested companies should provide brief details of their organizational setup, technical expertise, and experience in executing signaling projects, including information on project scope, location, client, and completion timeline.
- 1.5 The tenders shall be available as per advertised tender notice. The bidders may send, in writing well in time any questions and enquiries for clarifications regarding the project/specifications, to the Project Director / SUP, Pakistan Railways, Head Quarters office, Lahore. Necessary clarifications shall be issued to all those who had download the tender documents through E-PADS.
- 1.6 Bidders are encouraged to propose local manufacturing or assembly of signaling equipment, either in joint venture with Pakistan Railways or independently. Proposals should consider the old and the upcoming re-signaling needs across to ensure compatibility/integration with the CPEC ML-1 project.
- 1.7 It shall be the requirement of the tender to do the maximum possible System Engineering/Design locally. Similarly maximum possible local staff shall be utilized for installation of the equipment. Railway Engineers and Technicians shall also be involved at each stage of System Engineering and Design so that they are adequately trained to take the responsibility independently.
- 1.8 Building, electrical and any / all other allied works design must be approved from the relevant department of Pakistan Railways prior to the implementation.
- 1.9 Pakistan Railways reserves the right to accept or reject any tender without assigning any reason.

Employer's Requirements

- 1.10 All signaling equipment shall conform to CENELEC and SIL-4 standards. Equipment based on other standards shall be accepted only with independent third-party certification proving full equivalence to CENELEC and SIL-4 requirements while ensuring compatibility and integration requirements.
- 1.11 Only field-proven systems successfully used by major international railways shall be accepted. Minor local adaptations are permissible. Performance certificates conforming reliable operation must be provided. Prototypes or untested systems are not acceptable; preference is for off-the-shelf standard products ensuring long-term maintainability.
- 1.12 The All equipment shall be of high quality and durable construction, capable of withstanding local climatic conditions and vibrations from trains up to 160 km/h. The system must ensure fast and reliable response—all operator commands or control signals shall be executed with minimum latency and high precision. Equipment shall also be immune to electrical and traction interference to maintain continuous and safe operation.
- 1.13 The software shall be fully licensed, perpetual, and free from limitations on users, equipment, or connections and time (Supporting Un-Limited Time working). It shall remain compatible with all supplied systems and support integration with existing and future railway infrastructure, including ML-1 and other modernization projects, without additional licensing or replacement needs. All updates, patches, and upgrades necessary for functionality and security shall be provided at no extra cost. The software must include robust cybersecurity features—ensuring data integrity, access control, and protection against unauthorized intrusion. It shall be modular, scalable.
- 1.14 The bidder shall provide complete documentation, including technical specifications, software architecture, licensing details, and compliance certifications, ensuring transparency, traceability, and long-term scalability. Source code escrow or access provisions shall also be included to safeguard Pakistan Railways' operational independence.
- 1.15 The contract will be for the full and complete operative system and any equipment/material required directly or indirectly for completion of the project shall be deemed to have been included in the total price of the Contract Agreement.
- 1.16 The bidder shall submit a comprehensive Project implementation plan comprising of site surveys, design, delivery schedule, installation schedule, covering all pre-installation and interface activities (e.g., track improvements, site readiness, civil works) followed by testing and training plans which shall be executed prior to final taking-over. The schedule must ensure timely coordination with Pakistan Railways. While Pakistan Railways will facilitate regarding preparatory works, the overall responsibility for planning, sequencing, and timely execution shall rest with the bidder.
- 1.17 The bidder shall provide dedicated, secure, and well-organized rooms or partitions for fiber termination and management within each installation site. The design shall ensure easy access, labeling, and maintenance of all optical fibers. Adequate space, routing, and termination panels shall be provisioned to allow independent utilization of spare or unused fiber pairs by Pakistan Railways for future signaling, communication, or data transmission needs. All fiber terminations shall comply with recognized international standards for optical cabling and network reliability.
- 1.18 Interlocking for Level Crossing shall be implemented on the gate leaf or Bamboo Barrier Machines as per site requirement.

Employer's Requirements

- 1.19 No additional level crossing signals should be added after the finalization of the design.
- 1.20 The bidder must supply spot cooling for the system to ensure the equipment rooms maintain an optimal temperature.
- 1.21 Each bidder shall submit a detailed, item-wise statement of compliance against every clause of the technical specifications. The compliance statement must be clear, specific, and elaborated, avoiding general or ambiguous terms such as "Complied" or "As per standard." Bidders shall provide supporting references, datasheets, and evidence of conformity for each item to ensure transparent evaluation and to prevent misinterpretation or low compliance during technical assessment.

2. BRIEF DESCRIPTION OF EXISTING SYSTEMS

2.1 SARHAD:

The station was equipped with All Relay Interlocking Standard-III (Siemens). Both adjacent stations are CBI (Computer Based Interlocking) and interface with a non-CBI system. During the flood/heavy rains of 2021, the Sarhad station was completely damaged, resulting in the failure of the signaling system. To avoid train detention due to piloting and PLC issues, the station has been temporarily closed.

- 2.2 For detailed understanding of existing systems of working trains, the bidders are advised to study General and Subsidiary Rules of Pakistan railways and stations Yard Plans. Sketches of Yard Plans have been attached with the tender documents while detailed plans are available in the office of Chief Signal & Telecom Engineer / D&P and can be consulted if required. The bidders may also survey the stations for which a formal request to Project Director / SUP shall be made at least one week before the proposed visit. Pakistan Railways shall not be responsible for any shortage for material on any account quoted by the bidder.

Employer's Requirements

3. TRACK STRUCTURE

- 3.1 Track Gauge is 1676 mm.
- 3.2 Gradient within the project area is less than 1 in 300 on both Up and Dn lines.
- 3.3 Degree of curve varies from 0.3 to 3.5° on both Up and Dn lines.
- 3.4 Track is laid on ballast of a depth of 300mm on Up line. The quantity of ballast may however be less on the old track.
- 3.5 Main line rail is 100RE/UIC 54 and Loops and sidings are of 90 lbs and 75 lbs.
- 3.6 Rails are laid on wooden or concrete sleepers at generally 60cm spacing. Points and crossings are laid on wooden timbers. Concrete sleepers are predominantly Monoblock Prestressed concrete.
- 3.7 Rail fastenings on PSC sleepers are
 - a) Elastic Rail clips on 100RE, 90 Lbs and 75 Lbs rails.
 - b) Vosoloh on UIC-54 rails

On wooden sleepers, dog spike or round spikes are used.

4. SALIENT FEATURES OF PROJECT

- 4.1 It is proposed to provide Computer Based Interlocking (CBI) at Sarhad, station in accordance with SIL-4 and CENELEC standards. For further details please refer Annexure A-1 of this chapter.
- 4.2 Axle counter Block shall be provided between the stations and shall be controlled through the station CBIs. The adjacent stations to the last CBI station of a section shall also be provided with Axle counter block.
- 4.3 Associated Telecommunication facilities shall be provided.
- 4.4 UPS with standby Diesel Generator sets shall be provided.
- 4.5 Maintenance free batteries / battery banks that are compact and easy to relocate to another location.
- 4.6 Ensure stable and uninterrupted power supply to the CBI system and all equipment and should be robust enough to handle current and voltage fluctuations / surges
- 4.7 Rehabilitation of the Track by providing sleepers (including but not limited to timbers, fittings, fastenings, chair plates and other related items for points and crossings etc.) as per Pakistan Railway standards to make it suitable for track circuiting.
- 4.8 The provision of Insulated gauge tie plates and stretcher bars.
- 4.9 Design and construction of Buildings and allied works including equipment rooms, level crossing huts, maintenance center and residences / offices. Bare minimum tentative details have been provided in annexure A-4.
- 4.10 Tool kits one for each station, having all necessary Testing/repair and maintenance tools for routine maintenance shall be provided. A sample format of toolkit is attached in Annexure A-5.
- 4.11 The bidder shall provide supervision of maintenance services for a period of two (2) years after completion, all response times, performance indicators, reporting obligations, and penalty provisions defined in the Supervision of Maintenance Guidelines (SOM) shall apply without exception. The bidder shall ensure continuous technical support, preventive maintenance, and adherence to PR's operational standards to maintain system reliability and safety throughout the maintenance period.
- 4.12 Spot cooling arrangements for all equipment cabinets (equipment rooms) to maintain optimal temperature according to site requirements

Employer's Requirements

-
- 4.13 The bidder shall supply all essential, original, and compatible spares required for smooth system operation and maintenance for a period of two (2) years after commissioning, in accordance with the Supervision of Maintenance (SOM). All spares shall be itemized and traceable to ensure timely replacement and uninterrupted service availability as defined under the SOM definitions. Level crossing in the yards shall be interlocked complete in all respect.
- 4.14 The bidder shall be responsible for preparing and implementing a comprehensive training program for Pakistan Railways staff, covering system operation, maintenance, diagnostics, and safety procedures. Using the Railways' provided training template, the bidder shall develop a detailed training plan, schedule, and supporting documentation, including manuals, presentations, and practical modules. All training materials and records shall be submitted for approval prior to commencement to ensure alignment with system configuration and operational needs.
- 4.15 Provide 5 man-months local training as mentioned in Chapter-I.
- 4.16 Maintenance & Repair center to be set up at a one place to carry out repairs to all equipment which cannot be repaired on site. The successful bidder shall recommend the tools and plant in form of kit for Repair center. Details of design, circuits, components, manuals etc. along with sources of supply shall be supplied for carrying out repair and maintenance.
- 4.17 Supply and installation of the equipment for each type of system/equipment in the model room of Pakistan Railways Academy, Walton for the purpose of training the technical staff.

5. TECHNICAL DOCUMENTS TO BE SUPPLIED WITH THE BID

The bidders must supply complete technical documents relating to the equipment offered, which will include the following: -

- 5.1 The technical literature/specifications of all the equipment offered.
- 5.2 The typical circuit arrangements in diagrammatic form for all offered systems.
- 5.3 Basic diagrams to facilitate the understanding and functioning of the system.
- 5.4 Extract of various standards/Specifications used for system design and equipment.
- 5.5 Necessary design such as low level, high level, As build and Final Design.
- 5.6 User manuals for all component's Hardware / software.

6. STATEMENT OF COMPLIANCE

Every bidder shall submit an item-wise statement of compliance to the specifications.

7. SUPPORT TO BE PROVIDED BY PAKISTAN RAILWAYS

Pakistan railways shall extend its support to the successful bidder for the following: -

- 7.1 Arrangement of 380V three-phase (+10%, -20%) electric supply for the equipment rooms. Bidders shall inform the load requirements for each station.
- 7.2 Necessary co-ordination and help to work on Railway premises. The contractors shall however take all necessary precautions required for working in a running system so that there is no / minimum disruption to train services and safety is ensured.

Employer's Requirements

8. COMPLETION TIME

The bidders shall indicate the minimum possible completion time for completion of signaling works. It is desirable to complete the work within maximum 24 months of signing of the contract.

9. PRICE QUOTATIONS TO BE SUMITTED IN TABULAR FORM

9.1 The bidders are required to quote for the complete work for Sarhad station with the following break-up of the costs: -

- (i) Supply of materials.
- (ii) Engineering and system design.
- (iii) Installation/commissioning.
- (iv) Construction of buildings for the system and accommodations along with electrical wiring according to the load of the system.
- (v) Supervision of maintenance for 2 years.
- (vi) Provision of Spares.

9.2 Details of each of these items should be provided, in respect of C & F cost, FOB cost and cost in local currency.

9.3 Schedule-A for the stations shown in Annexure A-1 to this chapter shall be filled.

9.4 Only major items have been mentioned in the schedule of prices. Bidders shall include sub details for each item. Any missing items shall also be included.

10. WARRANTY

All the equipment will have warranties against all design or manufacturing defects for a period of 24 months after the commissioning. Under this warranty, the contractor must repair or replace on site, free of charge, all equipment, which is no longer capable of ensuring seamless service.

Employer's Requirements

Annexure A-1

MAIN PROPOSAL

	STATION NAME	Distance from Kaimari (Kms)	Distance Between Stations (Kms)	Proposed / Existing system
	<u>Sukkur Division</u>			
	GHOTKI	535.35	13.67	CBI, Axle Counter Block
4.	SARHAD	546.71	11.36	CBI, Axle Counter Block
	MIRPUR MATHELO	560.71	14.00	CBI, Axle Counter Block

INTERFACING OF COMPUTER BASED INTERLOCKING (CBI SYSTEM)

Sukkur Division:

Ghotki CBI => Sarhad (Proposed for CBI) => Mirpur Mathelo (CBI)

Note:

- Interfacing with Ghotki (CBI) Station & Mirpur Methelo (CBI) Stations In Sukkur Division

Employer's Requirements

Annexure A-2

MANNED LEVEL CROSSINGS IN STATION AREA

S. No.	Station	Classification
7	Sarhad	Class-II

CLASS-I = 32 FEET WIDE.

CLASS II = 24 FEET WIDE

Annexure-A-3

LIST OF BRIDGES

Sarhad – Mirpur Mathelo section:

S No	Bridge No.	Location		Span
		Mileages	In Post	
1	269	344	2-3	2x40'
2	271	345	2-3	1x40'
3	272	345	10-11	6x40'
4	274	346	5-6	11x40'
5	275	346	10-11	4x40'
6	276	347	11-12	10x40'
7	277	347	17-18	1x40'
8	278	348	1-2	1x3'
9	279	349	5-6	1x13'
10	280	349	11-12	1x13'
11	281	349	11-12	1x20'
12	282	350	7-8	1x9x9
13	283	350	15-16	1x24'
14	284	350	23-24	3x40'
15	285	350	24-25	1x10'
16	286	351	5-6	2x40'

Employer's Requirements

Annexure A-4

TENTATIVE REQUIREMENTS FOR BUILDING DESIGN AND CONSTRUCTION

S No.	Description	Quantity	Tentative covered area (per unit sq ft)
1	Signalling Equipment rooms	1	2400
2	Level Crossing huts (stations)	1	50
5	Residence (Sub: Engineer)	1	1000
6	Offices for Sub Engineers	1	144

Annexure A-5

COMPREHENSIVE MAINTENANCE TOOLKIT FOR CBI SYSTEM

This below list is for one tool kit. Contractor has to provide one tool kit.

SN	Category	Item	Description	Qty
1.	Hardware & Electronic Maintenance Tools	Multimeter	True-RMS digital multimeter for measuring AC/DC voltage, current, and resistance.	1
2.		Clamp Meter	For measuring current in cables without breaking the circuit.	1
3.		Cable and Wire Fault Locator	TDR (Time Domain Reflectometer) for locating breaks, shorts, and faults in both electrical signaling cables and fiber optic cables.	1
4.		Insulation Resistance Tester (Megger)	For testing the insulation quality of power and signaling cables.	1
5.		Network Cable Tester	For RJ45/RJ11 cables, to check for continuity, miswiring, and length.	1
6.		OTDR (Optical Time-Domain Reflectometer)	Essential for characterizing fibers and finding faults (breaks, bad splices) in the underground fiber network.	1
7.		Light Source and Power Meter	For measuring signal loss (attenuation) across a fiber link.	1
8.		Visual Fault Locator (VFL)	A red laser pen for identifying macro-bends or breaks in fiber.	1
9.		Oscilloscope	Portable digital storage oscilloscope (DSO) for analyzing complex electronic signals.	1
10.		Soldering and Desoldering Station	For PCB and component-level repairs.	1
11.		Hand Tools	Comprehensive set including screwdrivers, nut drivers, pliers, strippers, and cutters, L-keys,	1

Employer's Requirements

			wrenches etc.(these should be compatible for opening all the indoor and outdoor equipment installed on the sight)	
12.	Software & Diagnostic Tools	Engineering Laptop	Ruggedized laptop pre-loaded with necessary maintenance software, kept offline/air-gapped.	1
13.		Diagnostic and Configuration Software	Licensed software for diagnostics, event log analysis, and configuration of controllers.	1
14.		Data Backup and Recovery Kit	External drives, bootable USBs, and restoration software for secure system backups.	1
15.		Portable Disk Duplicator	For cloning and deploying hard drives/SSDs from a known-good image.	1
16.		Serial Console Cable/Adapter	USB to Serial (RS-232) adapters for configuring industrial network equipment.	1
17.		Password Manager / Secure Database	Encrypted vault or air-gapped system for password and license storage.	1

11. GENERAL MATERIAL REQUIREMENTS

11.1 GENERAL

- 11.1.1 All workmanship shall be of the highest standard, consistent with modern railway signaling and telecommunication practices, and suitable for the climatic and environmental conditions of Pakistan.
- 11.1.2 All work shall be executed in a neat, professional, and workmanlike manner in accordance with recognized international practices, and only by competent, qualified, and trained personnel.
- 11.1.3 All materials, equipment, and components used shall be brand new, of the best quality and suitable grade, and fit for the intended purpose with regard to duty, performance, reliability, and arrangement.
- 11.1.4 Bidders shall clearly indicate the expected service life, Mean Time Between Failures (MTBF), and other reliability parameters for all major equipment offered.
- 11.1.5 All equipment shall be of proven design and performance, conforming to the latest international standards and specifications, and consistent with modern signaling practices.
- 11.1.6 The use of wood or other inflammable materials for insulation, mounting, or fixing of apparatus is strictly prohibited.

12. Performance

All material, equipment and systems offered shall be entirely suitable for normal operation for their entire service life under the general climatic conditions prevailing in Pakistan.

1.1 Maintainability

Employer's Requirements

- 1.1.1 All separate identifiable components on sub units where constructed as integral modules shall be easily and readily removable for replacement in case of failure.
- 1.1.2 Such units shall be self-supporting and rigidly constructed such that during transport, installation, inspection and repair normal handling without risk of damage is allowable.

1.2 Standardization

- 1.2.1 Insofar as it is economical and practicable, the project shall be engineered to enable standardization of components. Performance shall be maintained at normal levels after replacement of components of equipment with equivalent parts of nominal or specified tolerance.
- 1.2.2 Wherever practicable and consistent with safety and reliability, similar components used in the installation shall be interchangeable.
- 1.2.3 All nuts and bolts screw threads generally shall be to the I.S.O. Metric Series.
- 1.2.4 The configuration tools of the system and the programming language shall be of a common standard such as PLC related tools and Programming.

1.3 Protective Finishes

The Contractor shall ensure that all equipment, casings and structures are painted and/or otherwise treated to positively prevent corrosion or deterioration under their conditions of use.

2. MATERIALS

2.1 Steel Sheets and Strips

Major materials of equipment racks/cases, external cable racks etc. shall be of cold rolled carbon steel sheets and strips to BS 1449 or aluminum alloy to BS 2897 or equivalent.

2.2 Copper Wires for Windings and Wirings

Copper Wires to be used in the windings and wirings of electric machines and apparatus, electronic equipment and electrical instruments shall be annealed copper conductor on which the insulating film of polyvinyl formal or polyester varnish is baked uniformly and perfectly. These films shall be harmless to the conductor and shall have sufficient durability. Other characteristics shall conform to BS 4516 and BS 4665 or equivalent.

2.3 Materials for springs

The material to be used for springs of relays and the like of electrical machinery and apparatus shall be of copper beryllium alloy, phosphor bronze and nickel silver-sheets, plates and strip for springs. The maximum surface stress value thereof under operating conditions shall not exceed the value of two-thirds the elastic limit of the material. Details shall conform to BS 2870 or equivalent.

2.4 Molding Compounds

The molding compounds to be used for relays and the like of electrical machinery and apparatus shall have high creep and contraction characteristics, and have sufficient dielectric strength against surge currents.

Employer's Requirements

2.5 Concrete

- 2.5.1 The Contractor shall use ready mixed concrete in ratio of 1:2:4. On site mixing may be carried out providing it is strictly supervised to ensure the quality of the concrete. Nominal maximum aggregate size shall be 10mm.
- 2.5.2 Concrete strengths shall be tested in accordance with PR specification for execution of works 1967.
- 2.5.3 Concrete for foundations of signals, apparatus cases, etc. shall have a minimum 28 days compressive strength of 3000 PSI.

Employer's Requirements

3. COMPONENTS

- 3.1 The components/I.Cs./Modules shall be of industrial type, well established and proven with regard to their reliability. As far as possible fire proof/fire retarding material must be used.

3.2 Push Buttons

- 3.2.1 Push-buttons and toggle switches if used shall be easily and securely mounted. No slackness shall arise in any part of these components during operation.
- 3.2.2 The push-buttons shall be equipped with each contact unit located in a visible place for inspection and with wiring connection.
- 3.2.3 Contact elements shall be designed for high reliability.

3.3 Counter

Counters shall be designed in such a way that no facilities for resetting the counter are provided on the faceplate. Counters shall be provided with four or more digits.

3.4 Indication Lamps and Sockets

- 3.4.1 The replacement of indication lamps or L.E.D. shall be practical and easy.
- 3.4.2 The sockets shall be designed for wiring connections of a non-soldering type.
- 3.4.3 The terminal metal fittings shall be constructed so not to cause a short circuit during mounting or demounting.

3.5 Buzzers

- 3.5.1 The buzzer shall be an electronic type which shall be able to generate continuously an audible alarm with variable loudness,
- 3.5.2 The buzzer unit shall support a minimum of four distinct alarm tones, each generated by different oscillating frequencies to clearly differentiate between various alarm conditions or system statuses. The tones shall be audible, reliable, and easily distinguishable under typical operating and ambient noise conditions.

3.6 Signal Fuses

- 3.6.1 Fuses shall have suitable capacity and be capable of breaking the circuit automatically when overload or short-circuit occurs,
- 3.6.2 The fuse shall have sufficient durability electrically and mechanically, and shall be so constructed that a melted fuse can be confirmed visually.
- 3.6.3 The replacement of fuses shall be practical, easy and safe.

Employer's Requirements

3.7 Circuit Breakers

- 3.7.1 Circuit-breakers shall be constructed solidly from materials of good quality, that shall ensure smooth operation, perfect electrical contact, and easy connection.
- 3.7.2 Circuit-breakers shall have a suitable breaking capacity in accordance with the load thereto and shall not operate by a transient rush current which occurs in the changeover of the electrical power. The inverse time-delay over current release characteristic, shall continuously protect the apparatus and the circuit thereof from the overload which takes place.
- 3.7.3 Circuit-breakers shall be capable of breaking the circuit instantaneously when a short-circuit occurs, and shall be capable of securing the re-closing of contacts just after the breaker is tripped by a short-circuit of overload, provided that the circuit is again normal.
- 3.7.4 The tripping mechanism shall be of a magnetic type independent of thermal conditions.
- 3.7.5 The circuit-breaker shall provide a mechanical trip indicator.

3.8 Electrical Indicating Instruments for Switchboards

The accuracy of electrical indicating instruments such as voltmeters and ammeters shall be $\pm 2.5\%$ and that of frequency meters $\pm 1\%$ of nominal value.

4. MANUFACTURING

- 4.1 The manufacturing shall be of the highest standard and the work be executed in a workmanlike manner.
- 4.2 The apparatus should be designed with such reliability that continued presence of maintenance staff is not required.
- 4.3 All wires and cables should be specially designed for use in Railway Signaling appliances and meet all requirements associated with safety, reliability, climatic conditions, type of soil etc. Cable must be fire retarding with termite and insect repellent additives.
- 4.4 Details of the actual practice for manufacture shall be in accordance with the manufacturer's normal standards except as stipulated otherwise.
- 4.5 All coatings shall be commercially smooth, substantially free of flow lines, streaks, blisters, and other defects that would impair serviceability or detract from general appearance.
- 4.6 Screws and nuts used subject to vibration shall be secured with spring washers etc.

5. LABELLING

- 5.1 Each individual piece of equipment or device shall be labelled with its individual identifying code corresponding to the plans, drawings and circuits in an approved manner.

Employer's Requirements

All such labels shall be engraved giving distinctive contrast between text and background. Self-adhesive embossed labels will not be accepted.

- 5.2 The device to which reference for maintenance, checking or fault finding is required at both front and rear shall be labeled both at front and back.
- 5.3 Groups of terminals, fuses or bus bars, shall be labeled with the designation of the group, and each individual terminal or fuse shall be numbered in multiples of five to facilitate ready identification.
- 5.4 All internal wires connected to cable terminals in equipment rooms and location cases shall be labeled to indicate the terminal number to which they are connected. At all terminations to which two wires are attached the individual wires shall be identified by an additional label in the form of an asterisk on one of the two wires which shall correspond with similar notation on the plans or circuit drawings.
- 5.5 Power circuits in excess of 110 volts shall be prominently labeled with warning signs including the nominal voltage. These signs shall be subject to the approval of the Employer.
- 5.6 All labeling shall be in English.
- 5.7 Each location case, equipment rack and cable termination box shall be labeled externally on the front door or cover with the title as given on the circuit and layout drawings.
- 5.8 Track feed/relay terminations shall specifically identify the polarity of the circuit by use of suitably coloured conductors.
- 5.9 All wiring labels shall be of the sleeve type and shall be attached to the wire before attachment of the termination crimp. Thereafter the label shall be held captive by the termination crimp.
- 5.10 Drawings tabulating all terminations shall be prepared for each termination, fuse or bus bar panel. All spare wires or cable conductors shall also be shown on these drawings.

C. Each equipment shall be provided with the name plate engraved or embossed in English, showing name, model number, manufacture number, manufacture year and manufacturer's name.

D. EQUIPMENT ROOMS, RACKS AND LOCATION CASES

1. General

- 1.1 The bidders shall calculate their requirement for the equipment rooms and other accommodations including electrical wiring at the station in accordance with their system requirements and needs of Pakistan Railways.
- 1.2 Sketches of equipment rooms etc., indicating the size of the rooms and depicting the floor channels, holes in the walls or ceiling, etc. for cables and wires shall be supplied and later on should be constructed by the bidders including electrical wiring.
- 1.3 The Signaling works shall follow after the civil works when these works are at an appropriate stage to allow uninterrupted progress of the installation of signaling works.
- 1.4 The equipment racks and location cases shall be pre-wired in the factories of the manufacturer complete with terminals, fuses, lightning arrestors, interconnecting cable, plug in connections and test terminals etc.

Employer's Requirements

- 1.5 The equipment should be easily accessible and replaceable.
- 1.6 Soldered connections can also be acceptable in the equipment racks and location cases, provided each is suitably identified and have easy access.
- 1.7 The equipment racks installed inside the rooms may be of steel or any other durable, robust, fire retarding material such as fiber glass etc. as recommended by the manufacturer of equipment.
- 1.8 External equipment, components, cable terminations etc. shall be housed in location cases. Due to frequent theft in the field of Iron parts, special fittings or other alternates shall be proposed so that it becomes very difficult to remove the location cases/boxes by unauthorized persons.
- 2. Locations Cases**
 - 2.1 The sizes and types of cases shall be kept to a minimum.
 - 2.2 The cases shall be of robust construction and made of durable material made of rust- proof steel or steel alloy of minimum 14 SWG.
 - 2.3 All equipment shall be mounted on slotted strips. All equipment shall be fitted above the lower ventilation louvers
 - 2.4 The location cases shall have front and rear access doors and a one-piece roof panel unit shaped to shed water.
 - 2.5 An earthling screw shall be fitted on one end face near the bottom of the case.
 - 2.6 The joint faces between the doors and the case body shall be gasketted.

Employer's Requirements

- 2.7 Louvers to permit full flow of air through the cases shall be provided.
- 2.8 Bases shall be of concrete. Provision shall be made for casting in the fixing bolts for the cases. The base shall include provision of cable ducting on all four faces and shall be capable of complete sealing after cabling has been completed, so that ingress of dust, vermin and snakes is prevented.
- 2.9 The bases shall be in the ground to a depth of not less than 750 mm. The base top shall not be less than 300 mm above ground level and not lower than rail level. The surrounding area shall be graded to a level surface over an area surrounding the case and the foundation to provide a clear walkway 1 metre wide on all sides of the case.
- 2.10 Location cases shall be fitted with a Jack-in point for maintenance telephone circuit.

3. Terminal Box – Signal Mounted

- 3.1 This shall comprise a terminal block for incoming and outgoing wiring.
- 3.2 The case shall be a rigid integral casting and shall be secured by a hinged gasketed door secured by a cylinder lock or shall have a hasp lug for padlock. In this case the padlock shall be permanently attached to the terminal box. Sealing arrangement shall be provided

4. Terminal Box – Point Machine and Track Circuit Junction Box

- 4.1 These boxes are for use adjacent to point machines and track connections to terminate different types of cables or at ends of ducts adjacent to track mounted plant.
- 4.2 Terminal boxes shall be cast iron boxes fully weather, dust and corrosion proof, designed so that the top is at least 150 mm above ground level.
- 4.3 These shall be provided with lockable or bolt down covers with sealing arrangement.
- 4.4 The box shall be mounted on a 50 mm diameter heavy gauge galvanized steel pipe or rectangular section made of heavy galvanized steel sheet, 1200 mm long and a welded base plate.
- 4.5 The underground connecting cable shall rise and enter the case through the pipe.
- 4.6 The connecting cables shall leave the box, through the bottom and run buried to the track. The exit holes shall be fitted with grommets to render them waterproof.

5. Terminal Box – Post Mounted

- 5.1 Post mounted boxes at least 250 mm above ground level may be used for junction boxes between main and branch cables and between external and internal wiring.
- 5.2 It shall be an integral casting with a gasketed cover secured to the box body. Locking and sealing arrangement shall be provided.
- 5.3 Cable entry shall be through metal ducts direct from the cable route. All entries shall be sealed from access by insects, vermin and snakes.
- 5.4 Connections to plant shall be through above ground galvanized steel conduit. Exit holes shall be fitted with grommets to render them waterproof.

Employer's Requirements

E. SURFACE FINISHES

1. GENERAL

- 1.1 This specification section outlines the minimum requirements for the surface preparation, priming, undercoating and finishing to be employed for all equipment supplied under this Project. The contractor shall render all the equipment corrosion proof by one or more methods and systems.
- 1.2 The Bidder may put forward with the tender his standard specifications for general painting and finish to manufactured equipment based on his past experience in countries having a tropical climate similar to that of project area.

2. APPLICABLE STANDARDS

The relevant CENELEC or equivalent standards shall be adhered to and shall form part of this specification. The latest issue of such documents shall apply.

3. METHODS OF WORKMANSHIP

- 3.1 All painting shall be carried out by qualified tradesmen employing only good painting practices and techniques and in strict observance to the directions of the paint manufacturer in respect of preparation, application methods, film thicknesses and re-coat times.
- 3.2 All materials selected for each system shall be fully compatible with each other.
- 3.3 Only spray or brush application methods shall be employed and Roller application will not be permitted.
- 3.4 Spray painting shall be undertaken with conventional air atomization painting equipment in strict accordance with the recommended procedures for operating that equipment.
- 3.5 Special attention shall be paid to achieve the specified dry film thickness.
- 3.6 Prime coatings shall be applied on the same day as the abrasive blast cleaning and before the steel surface shows any signs of tarnishing. Cleaned surfaces shall not be left to stand overnight without being re-cleaned immediately before application of the prime coat.
- 3.7 The Contractor shall exercise the utmost care in the handling and packing of equipment to prevent damage to paintwork during transport or installation. Where slings are used in the handling of painted surfaces they shall be adequately padded to avoid damage.
- 3.8 Where damage to paintwork has exposed bare metal, the exposed metal shall be thoroughly cleaned and all tracings of tarnish or rust and foreign matters removed, and the coatings feathered back and the system components, reapplied by brush to the required dry film thickness. Where only superficial damage has occurred and the bare metal has not been exposed the repair shall re-instate the coatings to the required thickness.

Employer's Requirements

4. PAINTING COLORS

4.1 Signals

- (1) Signal structures and single posts - 3 feet from base shall be dull black and remaining shall be white.
- (2) Miscellaneous signal fittings and brackets - black
- (3) Signal aspects and Signal units - black.
- (4) Signal Aspect Hoods - black.

4.2 Points

- (1) Point's machines, detectors - Yellow.
- (2) Rods and Fittings - Black.
- (3) Point and trap Indicator - Black.

4.3 Level Crossing

- (1) Level Crossing Signals and Associated Posts and mounting hardware - as for main signals above.
- (2) Barrier Machines - Internal and External - Yellow.
- (3) Boom Arms - Red and white bands as per international practice.

4.4 Location cases and cable junction boxes

- (1) External Color - Silver Grey Internal color - White.
- (2) Where stainless steel is used in the construction the Employer / Employer's Representative may consider an unpainted finish.

4.5 Axle Counters Black

4.6 Equipment Racks - Dark Admiralty Grey.

4.7 Foundations Assemblies and fixing hardware - Hot Dip Galvanized.

4.8 TYPE APPROVAL

The above indicated colors are for guidance of the bidder and they may suggest different colors internationally adopted by the manufacturers. The Contractor shall prepare and submit a complete schedule of finishing systems and colors of all material and equipment for the approval of the Employer.

F. ENVIRONMENTAL CONDITIONS

1. CLIMATE AND WEATHER

- 1.1 The equipment installed must give satisfactory service in the climatic conditions prevailing in the area. Extreme hot, dust storms up to speed of 125 K.M.H, heavy rains and extreme variation in temperature (55° C in summer to almost freezing point in winter) and very high percentage of humidity (up to 95%) are common in this area.

Employer's Requirements

- 1.2 Adequate tropicalization process must be used for all equipment to be installed in non- air-conditioned premises. Bidders will suggest provision of Air Conditioning, if required for certain equipment. The ambient temperature inside a room is about 45 degree Centigrade during summer. The temperature of the room shall go higher due to internal heat of the equipment. Similarly the temperature inside the location case installed in open will be much higher.

2. ELECTROMAGNETIC ENVIRONMENT

All the equipment must be provided with its own noise-free enclosure where necessary to ensure correct operation and avoid permanent degradation due to:

- (a) Stray magnetic fields
- (b) Electrical interference conducted along power supply, input and output connections.
- (c) Radiated electrical interference.
- d) Interference derived from A.C. OR D.C. electric traction systems.

3. TEMPERATURE AND HUMIDITY

- 3.1 Air conditioning of equipment and station master rooms is not desirable. All the indoor equipment must operate continuously and correctly up to 55°C ambient temperature under the conditions stated above. The equipment working without the need for air conditioning shall be preferred. Railways shall however, consider to provide air conditioning as per recommendation of the manufacturers for long life of equipment and to avoid degradation. The outdoor equipment must function continuously and correctly in the open environment (up to 70°C).
- 3.2 No equipment shall suffer permanent damage by storage for an indefinite period or transport at ambient temperatures in the range - 10 degrees C to 70 degrees C and relative humidity up to 100%.
- 3.3 All temperatures quoted are ambient temperatures assuming that no heat is produced within the enclosure. In practice the temperature within a small enclosure such as an unventilated line side location case may rise to a higher value due to heat given off by the equipment itself. Design, construction and test procedures must be such that equipment will operate correctly under these conditions.

Employer's Requirements

- 3.4 The temperature and humidity conditions are such that, in combination, condensation may occur on and within equipment which shall operate correctly under such conditions.
- 3.5 Outside and portable equipment must be drip proof against malfunction caused by ingress of water or other liquids not only in the vertical plane but in any other direction.

4. MECHANICAL ENVIRONMENT

- 4.1 The equipment shall not suffer permanent damage by a shock equivalent to a free drop of 250 mm on to a solid surface. This solid surface shall be rigid, shall not itself deform under the impact and shall be sensibly flat.
- 4.2 The equipment shall operate correctly under the vibration conditions created due to running of trains at 160 Kms/hr. No equipment shall suffer permanent damage either by storage for an indefinite period or by transport by rail or road vehicle.

5. POLLUTION

- 5.1 All equipment must operate correctly in chemically polluted or dust laden atmosphere. Means must be provided to prevent either ingress of pollutants or their direct or indirect effects preventing correct operation or causing permanent damage during transport or storage.
- 5.2 The equipment shall be protected against the effects of chemically active pollutants and such corrosive substances.
- 5.3 The outside equipment must be resistant to attack by detergents, sewage, toxic substances such as weed killer and lubricating and fuel oils.

G. LIGHTNING AND SURGE PROTECTION

1. General

- 1.1 The bidder shall provide adequate lightning protection complete in all respects for all equipment susceptible to voltage surges or spikes which may appear in any part of the power supply, or the circuit as a result of switching or lightning.
- 1.2 The lightning arrestor device shall not allow the passage of current to earth at the system or equipment normal operating voltage, but shall provide a low resistance path to earth in the event of a surge for the dissipation of the surge current and shall prevent dangerous rise in voltage of the circuit. The breakdown voltage of the arrestors shall be sufficiently low to prevent damage to equipment.
- 1.3 The arrestor shall interrupt the flow of current to earth and shall be self-resealing so as to insulate the conductors or equipment from earth as soon as the voltage has fallen below the breakdown voltage of the arrestor device. The arrestor shall not be ruptured by the discharge and shall be capable of automatically and instantaneously repeating the discharge action as frequently as necessary.
- 1.4 In order to keep the damage to a minimum a zone concept is required in accordance with IEC Standard 1321-1 or an equivalent established international standard.

Employer's Requirements

1.5 The Contractor shall be responsible for the detailed design of appropriate protection, for the systems and equipment provided.

1.6 The bidder shall include full details of the protection proposed for all equipment.

1.7 Location of Surge Protection Equipment

1.7.1 All Surge protection equipment shall be grouped together in the closest practicable proximity to the earth bus bar and shall be electrically isolated, and shall be physically removed to the maximum extent practicable from other signaling equipment.

1.7.2 External cabling shall enter the equipment room as close as practicable to the main earth bus and surge protection equipment, and shall be as far away as practicable from the internal wiring.

1.8 CBI Equipment

1.8.1 Robust and effective protection shall be provided in respect of both internal and external CBI equipment. Suitable arrangements including deployment of fast response surge arrestors of suitable capacity and of proven design shall be provided.

1.8.2 The arrangements proposed shall have a substantial proven service history in the environment similar to that prevailing in Pakistan.

Employer's Requirements

2. EARTHING SYSTEMS

2.1 General

- 2.1.1 The earthing system complete in all respects shall provide for the safety of the staff and others by ensuring the effective and rapid operation of protective electrical equipment to prevent danger to life by direct contact and damage to equipment.
- 2.1.2 The earthing system shall ensure the safety of the staff and others from the effects of high potential gradients caused by high voltage lines, or from high potential gradients caused by direct or induced lightning discharges by bonding all exposed metalwork within an area such that differential voltages cannot occur. The earthing resistance measured at bus-bar shall not exceed the values given in the following table under any given circumstances at any time of the year.

EQUIPMENT	OBJECTIVE	RESISTANCE	REMARKS
Cable Shield	Induction Protection	10 Ohms or less	Common
Arrester	Lightning Protection	2 Ohms or less	Individual
Lightning Conductor	Lightning Protection	2 Ohms or less	Individual
Telecommunication Equipment	Lightning Protection	2 Ohms or less	Common
Power Supply	Lightning Protection	2 Ohms or less	Common
Exchange Switchboard	Earthing	2 Ohms or less	Common
Electronic Plant	Earthing	2 Ohms or less	Common
Other Equipment: Distribution Frame Location Cupboard	Earthing	5 Ohms	Common

Note: "Common" denotes that shared use with other earthing conductors is allowed in which case the lowest resistance shall be employed.

- 2.1.3 Earthing rods shall be for the exclusive use of signaling and telecommunications equipment. Earthing of plant installed in buildings other than equipment rooms shall be through the electric power supply earth for the building.

2.2 Earthing of Racks and Equipment Housings

- 2.2.1 All racks and equipment housings shall be earthed either directly to the main earth bus bar, or to subsidiary earth bus bars.
- 2.2.2 Earthing connections shall be a minimum conductor size of 10 mm² PVC insulated copper cable colored green.
- 2.2.3 Wherever practicable each rack or piece of equipment shall be connected by a separate earthing connection to the earth bus bar. Where this is impracticable and an earthing ring is established connecting groups of racks or equipment to the earthing bus bar, the various earth wires forming the ring shall be terminated and connected to ensure the continuity of the ring is maintained even when individual equipment is disconnected for replacement purposes.

Employer's Requirements

2.3 Earthing Bus bars

Earthing Bus bars shall be a copper bar of 25mm x 3mm and of suitable length for the number of connections to be made.

2.4 Earth Connections

The following arrangements are suggested. However the bidder may propose other earthing system to achieve the desired results as specified.

- 2.4.1 Earthing conductors shall consist of flexible cable conductor minimum size 10 mm² copper - PVC insulated, colored Green, suitably protected against corrosion and in one length. No joints shall be permitted.
- 2.4.2 The earth connections shall be terminated at the earth bus bar by an insulated crimp lug. Connections at the earthing system shall be by exothermic welds. Threaded or crimped connectors will not be accepted.
- 2.4.3 The connection point to the earthing system shall be accessible for visual examination and inspection of the termination.
- 2.4.4 At equipment rooms and buildings, and at location cases, two earth conductors shall be provided connected to the earthing rods at diagonal corners of the earthing system.
- 2.4.5 The Earthing System shall consist of a configuration of earthing rods interconnected by earthing conductor.
- 2.4.6 At equipment rooms and buildings the earthing system shall consist of a minimum 4 No. earthing rods in a rectangular configuration at the perimeter of the building.
- 2.4.7 At location cases the earthing system shall consist of a minimum 2 No. earthing rods at the diagonally opposite corners of the location foundation.
- 2.4.8 The earthing rods shall be interconnected by a buried earthing conductor consisting of a bare copper conductor minimum conductor size 7/0.85mm connected to the earthing rods by brazing or welding.
- 2.4.9 The earthing rods shall be 1500 mm long copper bonded steel not less than 15 mm diameter furnished with a driving cap, driving point, and where extended depths are required, interconnected with threaded couplings. The copper electro-plating shall be minimum thickness 0.25 mm.
- 2.4.10 The rods shall be spaced at a distance of not less than twice the driven depth of each installed rod.
- 2.4.11 Additional rods shall be driven where necessary to achieve the specified maximum earth resistance figure, and shall be connected into the earthing system as per 2.4.5 above.
- 2.4.12 All earth electrode systems shall be located such that they are outside the sphere of influence of any other earthing system.

Employer's Requirements

- 2.4.13 All wiring within the overall earthing system shall be as far as practicable separated from all other wiring, shall be run directly and without deviations, and shall be installed to be free of loops or sharp bends within the wire runs.
- 2.4.14 The Contractor shall record the position of each earth electrode and the resistance value of the earthing system and the date tested.
- 2.4.15 The bidder may propose an alternative method of earthing should he consider his method a more safe and effective arrangement

2.5 Earth leakage detector

The earth leakage detectors shall be provided if required as per the design of the system.

H. INSTALLATION

1. RESPONSIBILITY

- 1.1 The Contractor shall be responsible to design, construct, manufacture, supply, install and commission all the systems, complete in all respects except the jobs mentioned in item 7 Chapter A.
- 1.2 The system Design principles shall be approved from the Employer before detailed system design and starting of any installation work.
- 1.3 Any work in circuits or equipment in service shall be carried out only under the direct supervision of a representative of the Railways. The contractor shall employ a Project Manager and competent representative staff to have the whole responsibility for all works and supervision.
- 1.4 Prior to start of any installation work, the plan and diagrams must be approved by the Employer. This approval will however, not relieve the contractor of his responsibilities with regard to safe design, circuitry and workmanship and the contractor shall remain responsible for correctness of the engineering and design of the project/system.

2. STANDARDS

The installation work shall be performed in accordance with the relevant clauses of this specification and the provisions of the Contract.

3. PROGRAMME

The installation shall be carried out in accordance with the Installation Schedule which is to be submitted along with the bid. The detailed schedule shall be approved by the Employer before starting the work. The contractor shall update and submit progress of works on a monthly basis and should the Employer / Employer's Representative notice that the progress of works is not in accordance with the approved schedule, the contractor shall, within 15 days from the Employer's request to do so, adjust the Installation Schedule.

4. COMPETENCE OF CONTRACTOR'S STAFF

4.1 Supervisory Staff

Employer's Requirements

The Employer / Employer's Representative reserves the right to check on the competence of any of the Contractor's supervisory staff. The contractor shall report the names of all supervisory staff engaged for the work.

4.2 Installation Staff

- 4.2.1 The contractor shall give adequate training to all his installation staff, and he shall check on their competence before they are allowed to work on site.
- 4.2.2 No installation staff member shall be considered competent to carry out until he has satisfactorily submitted a sample of acceptable example of workmanship to his supervisor.

Employer's Requirements

- 4.2.3 The contractor shall be encouraged to engage Railway Engineers and Technicians (if available) on deputation for the period of installation and supervision and maintenance so that they are trained during installation.

4.3 Testing Staff

The contractor shall only employ such staff on testing duties as, in the opinion of the Employer, are adequately diligent and skillful in the type of testing to be done and who have not been directly concerned in the construction and installation of the work to be tested. The number of engineers employed for testing shall be adequate for the task and approved by the Employer.

5. GENERAL INSTALLATION

5.1 Installation

- 5.1.1 The contractor shall install all equipment and structures in accordance with the working drawings which have been prepared by the contractor and approved by the Employer prior to commencing any work on site. The contractor shall submit for approval by the Employer the working drawings at least 60 days prior to commencement of any work.
- 5.1.2 All equipment and structures to be installed on line side shall be located in such a way that there is no conflict with any part of the Pakistan Railways Schedule of Dimensions. Special attention shall be taken into the installation of point machines.

5.2 Supervision and Practices

The contractor shall ensure that all work is adequately and continuously supervised and carried out in accordance with sound engineering practices.

5.3 Delivery of Equipment and Materials

- 5.3.1 After clearance of the equipment by Railways at port, the contractor shall receive the equipment and take it directly to site or temporarily store it at Railway stores at Karachi where space shall be provided free of cost. Inland transportation/storage from port onwards (except temporary storage at Karachi) and further handling of the equipment will be the responsibility of the contractor.
- 5.3.2 The contractor shall prepare and submit a schedule for transport and storage of all type of equipment and materials to the Employer / Employer's Representative for his approval prior to commencement of the work.

5.4 Preparation for Change-over

To shorten the change-over period and preparation for pre-commissioning and testing phase, the contractor shall prepare and submit for approval by the Employer the pertinent procedure for commissioning/changeover of existing equipment at least 30 days prior to commencement of any works. As far as practicable all commissioning/change-over of existing equipment shall be affected by link removal and terminal strapping at main termination panels. In the case of points equipment change-over shall be arranged at times approved by the Employer to minimize interference with normal train operations.

Employer's Requirements

5.5 Modification of Existing Working Signal Apparatus

When the contractor wishes to modify, add, delete or alter any existing signaling circuitry, equipment such as mechanical interlocking frame, block working and level crossing protection facilities etc in any way, the following shall apply:

5.5.1 Preparation

- (a) The modifications shall be designed and implemented in the most economic and efficient manner, making maximum use of existing equipment, and avoiding or reducing to a minimum interference/delay to normal train operations during the modification or construction work.
- (b) The contractor shall submit two copies of all plans indicating the details of the proposed modifications to be carried out. These plans shall indicate the existing arrangements and also the modifications proposed by the contractor. Any modification work on existing equipment shall be carried out with the Employer / Employer's Representative's approval, and when pre-testing involving existing equipment is necessary, then an Employer's Representative must be in attendance. All details shall be submitted for approval of the Employer / Employer's Representative at least 60 days prior to commencement of any work.

5.5.2 New Work in Existing Locations

The contractors staff can execute the work in existing working locations, carry out any alteration to, or interference with working equipment if necessary under direct supervision of authorized Railway staff after getting approval of the Employer as follows: -

- (a) New wiring may be installed and tagged ready for installation on working equipment or connected to non-working cable terminals.
- (b) New wires shall not be installed on any working relay or other equipment.
- (c) Working wires, terminals, fuses, equipment etc., shall not be altered or interfered in any way.
- (d) Working wires required to be removed during any commissioning stage are to be previously tagged if possible; where only one of two or more working wires have to be removed from the same terminal or connection, only the affected wire or wires shall be tagged.
- (e) A minimum of 7 working days notification to the Employer / Employer's Representative shall be given for minor alterations to working equipment and 14 working days modification for commissioning of new equipment.

5.6 CONCRETE WORKS

5.6.1 General

- (a) All concrete foundations for signal equipment shall be designed and constructed by the contractor to suit the soil content and stability of the ground.

Employer's Requirements

- (b) All external surfaces shall be symmetrical and free from voids and protrusions. Surfaces shall be trowelled smooth.
- (c) Where steel reinforcement is required it shall be provided by welded mesh of a size adequate for the loading requirements.
- (d) The contractor shall submit the drawings of foundations to the Employer for his approval prior to the commencement of any concrete work.

5.6.2 Mixing

5.6.2.1 All concrete shall be mixed in mechanically operated mixers, except when permitted by the Employer / Employer's Representative, may be mixed by hand methods. Hand-mixed concrete shall be mixed on a watertight, level platform. Proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform.

5.6.2.2 All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement.

5.6.3 Curing

All newly placed concrete shall be kept continuously wet by the application of water for a minimum period of 7 days after the concrete has been placed. Cotton mats, rugs, carpets, or sand blankets may be used as a curing medium to retain the moisture during the curing period.

5.7 WIRING WORK

5.7.1 General

Wiring must conform to the approved plans and must be uniform for similar apparatus throughout the system.

All vital circuits must be kept free of intentional and unintentional paths to earth.

5.7.2 Wiring

- a. Special attention shall be taken to wiring in such a way that any kink, tangle or damage to the sheath or wires and cables will not occur.
- b. Cable/wire drums shall be lifted clear of the floor and shall be rotated when the cable/wire is removed. As the drum is rotated, the wire shall be held clear of the floor and clear of any obstruction throughout its length.
- c. Sufficient staff shall be employed to ensure that this operation is carried out as specified. The required cable/wire length shall be cut off and then shall be lifted into the wire way to ensure that there is no possibility of the cable/wire dragging on the edges of racks and chafing the insulation.

Employer's Requirements

- d. Where it is necessary for the wire to be threaded and pulled through holes and apertures great care shall be taken to ensure that no damage occurs to the insulation, particularly by rubbing on other wires.
- e. Cables and/or wires shall be arranged to lie neatly on the horizontal and vertical sections of the wire ways.
- f. Where a deviation in the wire way occurs, i.e., at bends and vertical to horizontal junctions, etc., the wires shall be protected against undue tightness by some form of soft material such as wood or compressed paper, which can be removed at the end of the operation. By this means sufficient 'slack' should be provided to ensure that, apart from the weight of the wiring, no extra load is placed on the conductors passing from one plane to another.
- g. Adequate 'slack' shall be left in the wires to facilitate the removal of plug-couplers, terminations in location cases etc., which are attached to the wiring terminations.
- h. The jointing of wires is forbidden.
- i. It is considered preferable for individual wires to be run instead of multi-core cables if the sheathing of such cables would have to be stripped from a large part of their length.

No attempt shall be made to withdraw spare conductors from cables. Spare conductors shall be terminated in a manner acceptable to the Employer.

5.7.3 Stripping of Wires

- a. Wire stripping shall be carried out only with stripping tools suitable for the type of wires to be stripped.
- b. These tools will be subject to the approval of the Employer / Employer's Representative.
- c. Care shall also be taken when stripping the sheath from a multi-core cable to avoid damaging the insulation of individual wires, and when stripping the insulation from the wires to avoid damaging the conductors.
- d. Where armoured cable is to be terminated the outer sheath and armour shall be stripped back to the same point, leaving the inner sheath and cores as a terminating "tail". The boundary between the outer sheath/armour and the inner sheath shall be sealed by an adhesive lined shrink sleeve.
- e. The insulation on all wires shall be stripped to the correct length before insertion into the crimped termination to ensure that the correct length of insulation and conductor are held in the termination i.e., the tag not only grips the conductor, but also the shoulder of the tag holds the insulation to give the greatest mechanical strength to the termination.

5.7.4 Crimping and Stripping Tools

- a. Only ratchet type crimping tools fitted with a guard to ensure the correct insertion of the crimp terminal into the tool shall be used.

Employer's Requirements

- b. Each crimping and stripping tool in use shall be examined by the supervisor in charge at the beginning of each shift to ensure that it is in good order and the correct head fitted. Two samples shall be marked for identification purposes, and they shall be available for inspection at any time by the Employer / Employer's Representative.
- c. If any faulty stripping or crimping tool, or crimping tool with an incorrect head is found in the examination then the attention of the Employer / Employer's Representative shall be called with a view to examining the work previously carried out by the person(s) using that tool.

5.7.5. Labeling

Wiring labels shall be placed on the wire at the time the installation of wiring is in progress. The labels shall be non-metallic and durable. The Contractor shall replace any incorrect labels or labels fixed in the wrong position prior to taking over by Railways.

6. INDOOR INSTALLATION

6.1 GENERAL

An inspection of all racking, channeling, wire ways and internal cable routes will be carried out by the representative of the Employer before the running of wires is commenced. On completion of such assemblies the Contractor shall advise the Employer / Employer's Representative when this inspection may be carried out.

6.2 EQUIPMENT ROOMS

- a. The Contractor shall submit for approval by the Employer the layouts of equipment to be installed in signal equipment rooms at least 60 days prior to commencing any installation works.
- b. Equipment racks, terminal boxes, MDF, power distribution panels shall be placed robustly and level on the concrete base. They may be braced to the ceiling or to the walls of the building.
- c. Special account shall be taken in the installation of standby alternator sets in such a way that the working vibration of the machines will not cause malfunction of other adjoining equipment.

6.3 CLEANLINESS OF WORK AREAS

Station Master's office, equipment rooms, power rooms, and any other offices concerned must be maintained as clean areas.

6.4 OPERATING OFFICES

When installation work is necessary in rooms occupied by operating staff such as Station Masters, Train Dispatchers, noise and other distraction shall be kept to a minimum to reduce any interference to their normal duties.

Employer's Requirements

6.5 ACCESS TO RESTRICTED AREAS

Access to Station Master's offices, control offices and equipment rooms shall be restricted to staff employed on legitimate work and to persons who have legitimate business in such buildings. The contractor shall co-operate fully in this matter to ensure that no unauthorized person is allowed access.

7. INSTALLATION OF FIELD EQUIPMENT AND CABLES

7.1 SITE SURVEY

1. The general location of signals and other equipment's are as shown on yard layout plans included as Annexure-W. These positions are approximate and the exact locations will be determined by site conditions and other considerations such as sighting of signals etc.
2. Prior to the commencement of any installation at site the Contractor shall carry out a detailed survey jointly with Railway staff. The survey shall determine the position and location of all new equipment and buildings etc. to be installed and the alignment and type of all cable routes.
3. The details shall be recorded on a set of field survey notes and plans. The notes and plans will record the survey details and shall include all relevant details such as:-
 - Longitudinal position and distance to nearest running rail of all signals, height of foundation and height of mast, and any special requirements for signal lenses such as spread lenses or deflecting lenses.
 - Point's equipment.
 - Position and type of all Insulated rail joints, track circuit limits, fouling marks etc.
 - The site of all buildings, equipment cases etc.
 - The alignment, depth and type of all cable routes and shall include details of any hazards, awkward situations, obstructions or civil works and existing facilities such as retaining walls, platforms, ramps. Bridges, drains etc., and the proposed method of dealing with them.
4. All longitudinal measurements shall have reference to a permanent fixed datum which shall be noted on the plan to ensure that the future setting out of the works conforms to the intentions of the survey.
5. The contractor shall submit the field survey details and plans to the Employer for formal approval at least 30 days prior to commencement of any installation. No installation work shall commence prior to the Employer' approval.

7.2 SIGNALS

- a. The signals shall be installed with the top surface of the foundation at rail level.

Employer's Requirements

- b. The height of the lowest, (most restrictive aspect) of Main Signals shall be standardized at 4.44m above rail level, except where special sighting conditions may require higher signals.
- c. Foundations shall be level and signal masts shall be vertical in all planes.
- d. The signals will be mounted on concrete foundation 45 cm x 45 cm square at the top and of such length that the block should be 1.2 meter below the settled natural ground level. The signal pedestal shall be fastened with four holding down bolts of mild steel each having a length up to base of foundation and minimum diameter of 1.9 cm. The top of the bolts should be threaded up to 8 cm for taking two nuts with plain and spring washers. The bottom of the bolt should be of U type or welded plate.

7.3 POINTS EQUIPMENT

- a. Points equipment shall be located clear of Railways Schedule of Dimensions, and handed to ensure ease of maintenance and the safety of staff, with due consideration for shunting operations.
- b. Before installation of the points machines the contractor shall prepare detailed installation drawings for the approval of the Employer. The installation of points equipment shall be under the observation and supervision of the Railway representative.
- c. The contractor shall submit the installation procedure and programme for the approval of the Employer a minimum of 30 days prior to commencement of the installation.

7.4 TRACK CIRCUITS

- a. Track boxes shall not normally be located less than 2.5m from the nearest running rail, and shall not exceed rail level.
- b. Track circuit limits at clearance point shall be not less than 3.5m from the fouling point.
- c. Track circuit limits at Main Signals shall generally be located at minimum 15m, maximum 20m beyond the signal so that the driver does not normally observe replacement of the signal.
- d. Prior to commencement of the installation, the contractor shall prepare insulation and bonding plans for the approval of the Employer.
- e. The plans shall be submitted for approval a minimum of 30 days prior to commencement of the installation.
- f. Pin brazing shall be used for rail bonding purposes and also for connecting feed/relay end wires and jumper wires.

Insulated Rail Joints

- g. Rail cutting for the installation of rail joints shall be subject to the Employer's approval. The contractor shall show all locations of proposed rail cutting on the Rail bonding plans submitted for approval.

Employer's Requirements

- h. The rail cutting and fixing of Insulated rail joints and other track related works shall be carried out under the supervision of Railway's representatives at the time of the day suitable for the work.
- i. Due consideration shall be taken of the accurate alignment of the joint gap and alignment and diameter of holes of the securing plates to ensure correct installation of the insulated joint.
- j. Securing bolts shall not be bent, and any such bolts shall be discarded and shall not be used.

7.5 CABLING AND CABLE ROUTES

7.5.1 General

- a. Cable routes will mainly consist of buried cables laid direct in-ground, and in conduits through station platforms and bridges, under-track and under-roads.
- b. This will apply equally to cabling through block sections between stations and in station areas, and to main and subsidiary local cables.
- c. The Contractor shall clear and level the path selected for the cable routes prior to excavation and shall dispose of debris, obstacles etc, to a location permitted by the Employer / Employer's Representative.
- d. All cable routes will be constructed within Railway boundaries and rights of way, and wherever possible clear of any existing cable routes.

7.5.2 Cable Routes

- a. Main Cable routes shall wherever possible be buried. The Employer / Employer's Representative will give consideration to other types of route such as surface level concrete troughing of above ground ducting but only in special circumstances and to overcome particular difficulties or permanent obstacles. Each and every such exception will be subject to the specific approval of the Employer as to the type and extent and method of construction of the alternative route.
- b. The Contractor shall supply and install all cable route materials.
- c. In general, a single cable route shall be installed with the minimum number of changes in direction. Bends must not exceed the manufacturers specified minimum bending radius for the cables to be installed.
- d. Longitudinal cable routes shall be kept parallel to the track wherever possible and shall generally run at a distance of 3m from the centre of the track but not on the slope of the embankment.
- e. Routes crossing tracks and roadways shall wherever possible be at right-angles to the track/roadway.
- f. Cable route branches from the main route shall wherever possible run at right angles to the

Employer's Requirements

main route.

Employer's Requirements

- g. The cable route shall not interfere with drains and waterways.
- h. Where the route crosses an existing bridge structure it shall cross through G.I pipe conduits attached to the bridge structure. The fitting arrangement shall be approved from the Employer / Employer's Representative. The list of bridges is placed at Annexure-3 at the end of Chapter A.
- i. Cables and conduits will be laid at a minimum depth of 1200mm from the actual ground level to the top of the cables or conduits.
- j. The bottom of the trench shall be flat and shall be stable or compacted to be free of voids so that the cables are supported throughout their entire length.
- k. The cable routes must be clean and free of rocks and other obstructions to avoid damage to the cable during installation, and throughout service life which may result from vibration or the weight of the cable itself or other forces causing the cable to bear against these sharp obtrusions.
- l. All internal corners of the cable route and the entries of pipes and ducts shall have rounded or chamfered edges to avoid damage.
- m. Pipes or ducts shall have a smooth bore or internal surface, and shall have adequate diameter of dimensions to enable the cable(s) to be drawn through without damage.

7.5.3 Excavations

- a. The Contractor shall submit for approval by the Employer, field survey details and plans at least 30 days before any excavation or trenching is commenced.
- b. Care shall be taken during any excavation not to damage existing cable, wiring or equipment. The contractor shall bear the full cost of any repair, replacement or making good and return to working order of any damage caused by the Contractor.
- c. Any stipulations by the Employer / Employer's Representative in regard to the protection of the excavation and the safety of the track or of rail operations must be strictly observed.
- d. Work near or under track shall be adequately supported or shored to prevent the collapse of the excavation.
- e. Excavation where the general public or where Railways operating staff have access shall be suitably protected by barricades and signs. The excavation or warning signs shall be adequately illuminated at night.
- f. Ballast shall be protected at all times by a suitable protective covering from the spoil.
- g. Excavations shall be the minimum dimensions necessary for the performance of the work, and excavations for cable trenches shall be of minimum width for the cables/conduits which are to be installed, all other excavations e.g. equipment foundations shall likewise be as small as possible.
- h. The Contractor shall ensure that the excavated materials are placed to enable the

Employer's Requirements

backfilling in the order, depth, and density of compaction as originally existed.

Employer's Requirements

7.5.4 Cable laying and backfilling

- a. The Employer / Employer's Representative will inspect and approve in writing all underground cable installations and other excavations before backfilling. Wherever possible, trenches and other excavations shall be filled within 24 hours of excavation. Co-ordination with the Employer / Employer's Representative for inspection of work shall be made to minimize the time. Trenching and backfilling of cable routes shall be undertaken progressively and concurrently so that in normal circumstances the cable trench does not remain open longer than one week, except when the prior approval of the Employer / Employer's Representative had been obtained for the trench to remain open for a longer period.
- b. Backfilling will normally take up the majority of the excavated spoil. Surplus material after backfilling and compacting shall be deposited on adjacent railway land at locations and in the manner directed by the Employer / Employer's Representative.
- c. All cables shall be bedded on a 100mm minimum thickness layer of sand. The cables shall be covered by a further 100mm thickness layer of the same sand.
- d. The first cable to be laid shall be the Telecommunications cable. This cable shall be covered by 50mm of approved sand or soft soil. Thereafter the rest of the cables shall be installed. This does not exempt the contractor from meeting the minimum specified signal to noise ratio for communications circuits. The contractor may alternately give spacing of 75mm horizontally.
- e. The contractor shall be responsible for making good any subsequent subsidence that occurs during the guarantee at his own expense.
- f. In all cases, backfilling shall be consolidated by the contractor to avoid erosion. Where, in the opinion of the Employer / Employer's Representative, consistent erosion is likely to occur, cables shall be laid in galvanized iron pipe to avoid future exposure.
- g. Trenches and excavations through roads, within the track formation, in station yards, pathways, and platforms shall be compacted by approved methods using mechanical vibrators of an approved type. The compaction shall be carried out after backfill of each 150mm layer. The contractor shall ensure the excavated material is suitable for compaction by these methods. If the excavated material is considered unsuitable it shall be discarded and suitable material such as crushed rock shall be brought in.
- h. On completion of backfilling the area shall be left clean and clear of obstructions to the satisfaction of settlement leaving depressions along the alignment of the trench, and generally a small mound of excess fill shall be left along the line of the trench to compensate for future settlement.
- i. Where cables are to be laid direct in the ground in rocky locations, they shall be laid in a 50mm bed of clean sand or loam and covered with a 50mm layer of clean sand or loam. The next 150mm layer of backfill shall consist of screened 37mm max. aggregate.
- j. Where cables are protected by a suitable pipe, the sand bed and cover may be omitted, but the first 150mm layer of backfill shall be screened 37mm max. aggregate.

Employer's Requirements

- k. For rocky soil when digging beyond 500mm is not possible, the cable shall be laid in RCC pipe duly covered with concrete poured adequately on the top for proper protection and then covered with soil.

7.5.5 Under Track Crossings

- a. Where cables, excepting track circuit rail connections of jumpers, are to be laid under Railway tracks they shall be protected against damage in a manner approved by the Employer / Employer's Representative, and shall be installed and fully enclosed in ducts in accordance with the following:-
 - * concrete pipes reinforced in a manner approved by the Employer / Employer's Representative as a protection against subsistence of the track; or
 - * Galvanized steel pipes with screwed joints which may be laid direct in the ground without further protection.
- b. All ducts and pipes shall be well drained and have all joints effectively sealed, and be of sufficient strength to resist fracture due to track compaction.
- c. All ducts and pipes shall be laid not less than 1500 mm below the underside of the track sleepers, but may require to be deeper to align both the cables and route on either side of the track. The pipes and protection shall extend a minimum of 1500 mm from the outside running rail.
- d. After installation of any duct or pipe the formation and track bed shall be restored to its original condition.
- e. The minimum diameter of pipes shall be 100mm. The number of pipes shall be decided so that no cable has to run tightly from any pipe.
- f. The excavation shall be kept to a minimum width and shall generally not exceed the width of one sleeper bed. The Employer / Employer's Representative will support for the provision and placing in position of temporary track supports considered necessary and their removal on completion of work.
- g. The contractor shall give at least 7 days notice of intention to excavate.
- h. The contractor shall propose the method of work in the construction of under track crossings for the approval of the Employer / Employer's Representative.
- i. Boring or the driving of pipes under the track may be permitted at the absolute discretion of the Employer / Employer's Representative.
- j. All under track crossings shall be installed at right angles and shall in general be a minimum of two sleeper spacings clear of rail joints and 2m clear of any rail switches or the crossing area of points turnouts.

Employer's Requirements

7.5.6 Under Road Crossings

- a. Where any section of a cable route is constructed under a public road it shall be installed with the cables fully enclosed and protected to the following minimum requirements:-
 - * Concrete pipes reinforced in manner approved by the Employer / Employer's Representative minimum diameter 150 mm. or
 - * Galvanized steel pipes with screwed joints - minimum diameter 100 mm.
- b. The minimum depth below the road surface to the top of the uppermost conduits shall be 1500mm. Backfill shall be to the requirements of the concerned Authority and/or National Highway Authority.
- c. The number of pipes shall be decided so that no cable has to run tightly from any pipe
- d. The contractor shall be responsible for arranging with the Highway Authority, Police Department and any other authorities concerned for the necessary authority to excavate/boring and shall comply with all their requirements in connection therewith. All costs and fees in this connection shall be borne by the contractor. The contractor shall provide all necessary barricades, signs and warning devices required to protect the excavation.
- e. Where pipes, cables or conduits of public utilities obstruct the cable route, the Contractor shall lay the Railway conduits, and protect the public utility cables and conduits in such a manner as to avoid interference thereto, or as required by the Public Utility.

7.5.7 Routes through Platforms

- a. Where any section of a cable route is constructed under a platform it shall be fully enclosed and protected to the following minimum requirements :-
 - * Concrete pipes re-enforced in a manner approved by the Employer / Employer's Representative. or
 - * Galvanized steel pipes with screwed joints.
 - * Minimum diameter of the pipes shall be 100mm.
- b. The minimum depth below the platform surface to the top of the uppermost conduits shall be 300mm. Backfill and resurfacing of the platform shall reinstate it to the same condition as before the excavation.
- c. Spare pipes shall be installed in the proportion of 20% of the pipes in use rounded up to the whole number and a minimum of two spare pipes. Spare pipes shall be capped with an easily removable cap to prevent inadvertent installation of cables and infiltration of spoil.

7.5.8 Cable Pits

Cable Pits may be provided where necessary particularly conduit routes through platforms. Proper drainage and sealing shall be provided.

Employer's Requirements

7.5.9 Cable Laying

- a. All cable handling operations shall follow established practices and shall be subject to the approval of the Employer / Employer's Representative. Cables shall be laid neatly side by side. Entanglement and bunching shall be avoided at bends, in pits or at entries to equipment and housings.
- b. No underground joints shall be permitted. If any joint has to be made, it would be terminated in junction boxes at least 0.5 meter above the normal ground level. Cables shall be laid in as long a length as practicable to minimize in-line joints. Joints shall not in any case be installed within areas of waterways and cable lengths shall be adjusted accordingly.
- c. Installation methods shall ensure that the cable is not stressed by tension in excess of manufacturers recommendations and that the specified minimum bending radius is not exceeded either during installation or when in the final position.
- d. When cables are hauled, cable grips shall be subject to the approval of the Employer / Employer's Representative and the winch apparatus shall have a clutch which can be set to limit the tension being applied.
- e. When hauling, due account shall be taken so as not to damage the cable sheath. When hauling through pipes cable shall be hauled from a direction, which will minimize the length of cable that has to be passed through the pipe.
- f. Hauling lubricants shall meet the approval of the Employer / Employer's Representative.
- g. Rollers shall be used wherever necessary to prevent damage to cables, conduits or pits.
- h. Prior to cable hauling, pipe shall be cleaned with a suitable cleaning mandrel to remove any foreign matter which may be injurious to the cable sheath. Draw wires shall be installed in pipe routes during construction of the route and shall be left in position after completion of cable installation.
- i. The ends of all cables shall be kept sealed during storage and after installation with a watertight seal to prevent ingress and seepage of water between the cable sheath and cores.
- j. Where cables enter signal equipment huts or line side boxes, etc., each core shall be terminated on a separate terminal block in such a way that a sufficient length of core shall be available and neatly disposed so that broken cores can be re-terminated.

7.5.10 Cable Protection

- a. All underground cable routes shall have primary protection in the form of a continuous strip of orange colored "Buried Cable Warning" tape of suitable material strong enough to resist the force of pick axe during re digging, and installed 200mm above the cables or cable conduits. The tape shall have a minimum width of 225mm and at joints between successive lengths of tape an overlap of 2 meters shall be provided. Alternately, bricks may be laid breadth wise above the 100 mm sand layer above the cable.
- b. All underground cables entering signals, level crossing equipment, equipment rooms,

Employer's Requirements

equipment and cable racks/cases and telephone posts shall enter through the foundation

Employer's Requirements

Protected by a duct or other covering approved by the Employer / Employer's Representative thus affording complete protection of the cables leaving the ground.

- c. Underground track circuit cables shall enter the track circuit disconnection box via the steel pipe foundation post. Track circuit rail connection cables laid on the ballast and sleeper between the track disconnection box and rail shall be protected by flexible orange PVC conduit, which shall be impervious to continuous exposure to direct sunlight.
- d. Underground cables to point machines and points equipment shall be protected by flexible orange PVC conduit, extending between the point equipment cable entry gland to the below-ground cable depth and extending a minimum of 500mm along the cable at full depth.
- e. Cables shall not normally leave the ground at less than 1500mm from the nearest running rail.

7.5.11 Cable Route Marking

- a. All cable routes shall be designated by cable route markers. The markers shall be placed at every 30 meters on straight runs and at all deviations and branches of the cable route.
- b. The cable markers shall be high strength concrete blocks of length 75 cm, top 15x15 cm square and bottom 22x22 cm square. The marker shall be 15 cm above ground level on the cable trench and letter "C" with an arrow indicating the direction of cable shall be engraved on the side of marker. The portion of the marker above ground level shall be painted white and engraved letter "C" in black.

7.5.12 Cable Route Records

- a. The location of all underground cable runs shall be recorded by the Contractor on scale plans.
- b. The plans shall show the alignment, depth and distance from track of all cable routes; the type of route; the number of cables; the cable destination; cable core size; number of spare cores in each cable; the number of conduits and spare conduits; cable pits; etc.
- c. The contractor shall submit for approval all corrected cable plans within 30 days after the commissioning.

7.5.13 Cable and Wire Installation

- a. All wires must be continuous without splices between terminations.
- b. There shall not be more than two wires terminated on any one terminal.
- c. All vital circuit wiring must be kept free of intentional or accidental paths to earth.
- d. All apertures through which wiring or cabling passes shall be suitably protected by grommets or other suitable protection.

Employer's Requirements

- e. All corners, over which wiring or cabling passes shall be suitably rounded, chamfered or protected to prevent chaffing of the wires and cabling.
- f. Wire and cable entry to housings and signal apparatus shall be through bushings, glands, or specially formed entrances and shall be sealed to prevent ingress of moisture, rodents and insects.
- g. The seal shall be readily visible and removable for additions or alterations.
- h. The ends of all cables shall be firmly clamped or otherwise secured to prevent intentional or accidental stress being placed on individual conductors.
- i. The main signaling cable should not be directly connected with any signaling apparatus and should be terminated on a numbered serial termination box fitted in the equipment rack/junction/location box.
- j. Termination of cables should be such that testing facilities are available at various locations. Insulated disconnection links of detachable terminals will be provided. Testing should be possible without disconnection of the conductors and without risk of accidental cross connections with other conductors.
- k. Terminals must be of such design and quality that they last for the life of the cable.
- l. Termination of power cable should be distinctly marked and protected against any shock to the maintenance staff.
- m. Cable number tags of suitable material shall be provided on each cable every 15 meters when more than one cable is laid in the same trench for identification purposes.
- n. All multicore cables shall be terminated in numerical order of cores commencing with the lowest core number on the lowest termination number.
- o. All terminations shall be made to leave sufficient length of wire for a minimum of two re-terminations in the event of a wire broken at the point of connection, and to permit access for inspection of apparatus

7.5.14 Cable Jointing

- a. Multicore main cables shall be installed between terminating points without any jointing, unless otherwise specified herein.
- b. Should the Contractor consider in any particular case that a joint is justified by special circumstances he will obtain the prior approval of the Employer / Employer's Representative. Not more than one such joint shall be installed in any one length of cable. No underground joints shall be allowed.
- c. No intermediate jointing shall be allowed for any tail cable.

Employer's Requirements

8. QUALITY CONTROL

- a. The contractor shall introduce and maintain in operation an independent quality control procedure of the installation on the basis of sampling checks.
- b. Where such check reveals a departure from the acceptable standards, the faulty work shall be rectified and the Employer / Employer's Representative shall be advised. A complete check of all previous work shall also be carried out to establish the full extent of faulty work.
- c. The contractor shall submit a monthly quality control report detailing the result of all sampling checks.

9. SIGNALS NOT IN SERVICE

- a. Signal which are not yet in service or which have been taken out of service pending removal, shall be obscured and the aspects shall not be visible to the Train Driver.
- b. Signal lights shall be extinguished by the removal of the lamp, and in addition the signal lighting circuit shall be disabled by removal of the fuse or link. A "X" mark made of wooden strips shall be fixed on the signal.

I. QUALITY CONTROL

1. GENERAL

- 1.1 The contractor shall maintain complete procedures for the quality assurance and control in respect of all matters covering the designing, manufacturing, furnishing, installing, testing, commissioning etc. throughout the contract period.
- 1.2 The Employer reserves the right to examine the bidder's capability and the effectiveness of his quality assurance system, before placing any contract or immediately after placing a contract.
- 1.3 The Employer may appoint a Quality Assurance Engineer to visit manufacturers and sites at any period during the contract to ensure that supplies are of the required quality.
- 1.4 The standards for material and workmanship shall comply in every respect with the requirements as set down in this specification and the contractor shall ensure this objective is achieved both on-site and off- site, in accordance with the drawings and specifications with special attention being given to the inspection and testing of items critical to the safety of the overall system.

2. CONTROL OF SUB-CONTRACTORS AND INCOMING MATERIAL

It is the responsibility of the main contractor to ensure that the performance of sub-contractors conforms to the requirements of this document.

3. MAINTENANCE OF RECORDS

Employer's Requirements

- 3.1 The contractor shall maintain records which demonstrate the effectiveness of his quality system. The minimum requirement shall be to show the nature and number of deficiencies found, the rate of observations of checks made, the signature of persons making the checks, the quantities approved or rejected together with a record or preventative or corrective action taken.
- 3.2 All changes made by the Employer / Employer's Representative to specific requirements will be made in writing and the contractor shall insure that these are recorded and documents at production or installation locations changed accordingly. Hand written alterations on documents will not be acceptable as changes in these procedures. Obsolete drawings, documents and instructions shall be promptly withdrawn from issue and use.

4. TEST INSTRUMENTS

The contractor shall be responsible for providing, controlling, calibrating and maintaining inspection and measuring equipment suitable to demonstrate conformance of supplies to quality requirements. Equipment shall be used in a manner to ensure the required measurement capability.

Employer's Requirements

5. QUALITY ASSURANCE CERTIFICATE

A certificate shall be prepared by the contractor indicating the items which have been inspected and conform to the appropriate specifications and requirements.

6. INSPECTION

- 6.1 The contractor shall perform all inspections and testing at both the manufacturing premises and at the site necessary to ensure that the work is executed in accordance with the drawings and the specifications.
- 6.2 The inspection staff shall be qualified and experienced for the work they are required to undertake.
- 6.3 Special attention shall be given to the inspection and testing of safety critical items and those which may involve special process and inspection techniques.

7. CONCESSION PROCEDURE

In certain circumstances, at the discretion of the Employer, concessions may be granted for items not strictly conforming to drawings, specification and order requirements. Such concession shall only be applicable to item(s) which are necessary for effective implementation of the project as an equivalent or better alternate. Detailed reasons and compulsions shall be intimated by the contractor with their request.

8. SAFETY ASSURANCE

8.1 Procedures

Procedures shall be defined within the Contractors Quality System to provide control and proof of the safety of the overall signaling system. These procedures shall encompass Safety Management, definition of Safety Strategy, and production of the Safety Plan for the Project.

8.2 Safety Cases

Levels of independence for vital activities shall be defined and associated safety cases produced. These safety cases shall include, but not necessarily be limited to:

- (a) System specification.
- (b) Generic products already having proofs of safety.
- (c) Application design for hardware and software.
- (d) Manufacture, assembly and installation
- (e) Testing and commissioning.

In addition a total safety case for the whole project shall be produced.

8.3 Processor Based Systems

For processor based systems the inherent safety principles of the design shall be identified. All formal methods used for software implementation of the signaling interlocking shall

Employer's Requirements

be described along with details of all tools used for verification, simulation and functional testing of the application. Programming languages should be such that long term maintainability is assured by common “of the shelf” programming languages, tools and testing environment such as state of the art industrial PLC technology.

8.4 Safety Standards

The Bidder shall provide details of his Safety System, including conformance with recognized national or international standards and directives where applicable.

I. TRAINING

1. OVERSEAS TRAINING

- 1.1 Special attention is necessary in the training of technical staff that will become responsible for the overall upkeep of the new systems.
- 1.2 The contractor shall impart training to P.R. Personnel if deems essentially in the manufacturer's factories abroad for the one man months mentioned in Para 4.11 of Chapter-A (for bid purposes). All expenses including air travel, local transportation, boarding/lodging and daily allowance shall be quoted in the bid. The amount of daily allowance shall be kept as US\$ 100/day for bid purposes. Actual number of persons, man months and daily allowance shall be decided as per the recommendations of the successful bidder.
- 1.3 The Contractor shall provide training enabling the Engineers to gain comprehensive knowledge and understanding of software, its management, and to enable them to maintain the systems and undertake future software enhancements and modifications. In particular, the Engineers shall be given training in the software interpretation of signaling control tables, the related data preparation and testing, programming of the associated memory devices and make modifications as and when required as per revisions of yard layouts. The contractor shall also associate the Engineers of Pakistan Railways for software development, interlocking data preparation, and system design and testing.
- 1.4 In case the overseas training is not conducted due to any circumstances the Pakistan Railways will not make the payment for this bid portion.

2. LOCAL TRAINING

- 2.1 The local training courses shall cover all aspects of maintenance and operation of the equipment to be supplied to ensure that the personnel deputed for training are familiar with the equipment to undertake routine maintenance and operation.
- 2.2 The courses shall take place at the Railway Academy Walton and be timed to conclude before the taking over of the installation/system of which maintenance and operations are to be carried out by such staff.
- 2.3 The cost of training for Maintenance Supervisors, Maintainers and Operators of the signaling equipment will be quoted in the Price Schedules. However, the cost for transport, accommodation and meals for staff attending the training courses will be the responsibility of the Railways.

Employer's Requirements

- 2.4 The bidder shall quote a course of 4 weeks (for bidding purposes) mixed theoretical and practical for all systems for a class of Maintenance Supervisors and maintainers nominated by the Railways. The actual number of persons and duration of course (s) for the class shall be decided mutually. The course (s) shall be arranged in two groups as all the staff shall not be spared in one go.
- 2.5 The maintainers can also be given to the contractor on deputation for installation work so that they are fully trained.
- 2.6 The Contractor shall arrange a training course for reasonable number of operators. The course shall be of 6 days duration.
- 2.7 The contractor shall install working models of each equipment/system in Railway Academy Walton before starting training.

3. Guidelines for Training

3.1 General Requirements

- 3.1.1 The Supplier/Contractor shall provide comprehensive training to nominated Pakistan Railways personnel on the operation, maintenance, troubleshooting, and management of the Computer-Based Interlocking (CBI) System, including associated Level Crossing (L-Xing) and Communication subsystems.
- 3.1.2 The training shall be an integral part of the contract and must be completed before final system acceptance.
- 3.1.3 The training program shall cover both **foreign (OEM)** and **local** sessions to ensure complete knowledge transfer.

3.2 Scope of Training

3.2.1 Foreign Training

Shall be conducted at the Original Equipment Manufacturers (OEM) facility or an approved technical center abroad.

Duration: Minimum of one **man-month** (or as mutually agreed).

Participants: **5–20 nominated Pakistan Railways officials** (engineers, technicians, and operators).

Focus areas:

- System architecture and design of CBI.
- Hardware and software configuration.
- Communication protocols and data interfaces.
- Level crossing integration with CBI.
- Diagnostic tools and troubleshooting procedures.
- Safety standards, fail-safe operations, and system redundancy.
- Any other area deemed necessary for smooth operations

3.2.2 Local Training

To be conducted at the project site(s) and/or Pakistan Railways' training facilities.

Duration: **one man-month**, covering classroom and on-site practical sessions.

Participants: Operations, maintenance, and signaling staff.

Focus areas:

- System operation and daily functional procedures.
- Field equipment installation, calibration, and testing.
- Local maintenance, fault identification, and rectification.
- Hands-on exercises using actual system hardware and simulation tools.
- Interface between CBI, Level Crossing, and Communication systems.
- Any other area deemed necessary for smooth operations

3.3 Training Materials and Documentation

- 3.3.1 The Supplier shall provide comprehensive training materials in **English** (and if

Employer's Requirements

-
- required, Urdu translation), including:
- Detailed manuals (operation, maintenance, troubleshooting).
 - System architecture diagrams, wiring layouts, and software user guides.
 - Multimedia content (presentations, videos, simulation tools).
- 3.3.2 Training materials shall become the property of Pakistan Railways upon completion of training.
- 3.4 **Certification**
- 3.4.1 At the conclusion of training, all participants shall undergo an evaluation or test to assess their understanding.
- 3.4.2 Certificates shall be issued jointly by the Supplier/OEM and Pakistan Railways to all successful participants.
- 3.5 **Trainers' Qualifications**
- 3.5.1 Trainers must be qualified professionals from the OEM or authorized representatives with a minimum of **5 years' experience** in CBI systems.
- 3.5.2 Local trainers (for on-site sessions) must be certified by the OEM and approved by Pakistan Railways.
- 3.6 **Logistics and Expenses**
- 3.6.1 For foreign training:
- The Supplier shall bear all costs including air travel, accommodation, local transport, visa fees, and daily allowances for trainees.
 - Any training conducted abroad must comply with Pakistan government travel and training approval policies.
- 3.6.2 For local training:
- The Supplier shall provide all necessary training aids, tools, equipment, and venue arrangements.
 - Pakistan Railways shall nominate trainees and ensure their availability for the full duration of training.
- 3.7 **Training Schedule and Approval**
- 3.7.1 The Supplier shall submit a detailed **Training Plan and Schedule** within **60 days** of contract signing.
- 3.7.2 The plan shall include course contents, duration, location, trainer details, and training methodology.
- 3.7.3 Training commencement shall be subject to Pakistan Railways' approval of the submitted training plan.
- 3.8. Post-Training Support**
- 3.8.1 The Supplier shall provide **technical support and refresher training** for at least **12 months** after commissioning.
- 3.8.2 Additional on-site guidance shall be provided during the initial operation phase to address any operational issues.
- 3.9. Compliance**
- 3.9.1 All training shall be conducted in accordance with international railway signaling safety standards (e.g., EN 50126, EN 50128, EN 50129).
- 3.9.2 Any deviation from approved training modules must be justified and approved in writing by Pakistan Railways.

J. TESTING AND COMMISSIONING

1. SCOPE

- 1.1 This Section describes the requirements for testing vital and associated signaling equipment and systems, individual plant, parts of the installation, the whole installation, any further testing

Employer's Requirements

considered necessary and the commissioning and putting-to-work of the system.

1.2 Definitions

"Portion" - One interlocking station including the block circuits to one adjacent station.

"Factory Test" - The test performed at the Factory.

"Inspection Test"- The test performed at the Local Site Depot.

"Continuity Test" - Verification of the continuity and correct termination of each individual wire.

"Wire Count" - Visual inspection to ensure that the correct number of wires are terminated at each termination point.

"Unit Function Test" - Verification of the correct operation and functioning of each element (e.g. Control contacts, switch, fuse, link etc.) in a circuit.

"System Function Test" - Verification of the correct functioning of all sub-systems from the control panel/key board in accordance with locking tables and signaling principles, with point machines not in place by control and detection simulated by test boards.

"Apparatus Check" - Visual check to ensure that:-

- (a) Specified equipment quantities have been supplied
- (b) Specified materials have been used
- (c) Specified installation methods have been used
- (d) Standard of installation is adequate

"Pre-Site Test" - Test carried out at the contractor's depot or factory on plant and sub-systems that have been pre-fabricated and pre-wired.

"Local Test: - The operation and testing of apparatus and circuits in equipment rooms and location cases and trackside equipment directly connected thereto using local power supplies and control contacts.

"Through Circuit" - A complete circuit between signaling console and equipment room, control panel and locations, equipment room and location, location and location, Block systems and Telephone.

"Type Approval" - Shall mean that an item of plant, sub-system, sub-unit, module of component has been approved by the Employer for a specific application and is identified by Mark and Series number. Type approval shall not relieve the Contractor of any test as described herein.

"Provisional Acceptance Test" - The System Function Test for accepting a portion of the Works by Railways so that the portion can be commissioned and put-to-work.

"Commissioning Test: - Completion of the System Function Test at the time of final installation of all plant before Taking - Over by Railways and Putting - to - Work.

Employer's Requirements

2. DESCRIPTION

- a. To ensure the safe working and operation of the whole of the equipment supplied and installed by the contractor, installation checks and electrical and functional tests shall be carried out by the contractor as detailed in this section.
- b. No installation or part of an installation shall be brought into use until all tests, by both contractor and the Employer have been satisfactorily completed.
- c. With the exception of "System Function Test", all tests specified are the direct responsibility of the contractor and shall be carried out by the contractor to the satisfaction of the Employer.
- d. The "System Function Test" shall be performed as the "Provisional Acceptance Test".

3. DOCUMENTS TO BE SUBMITTED

The following documents shall be submitted by the contractor within the periods stated.

3.1.1 90 days after date of issue of Notice to Proceed.

- (a) Factory test program
- (b) On site test program
- (c) Commissioning program

3.1.2 90 days before commencing a test program

- (a) "Testing code of Practice" by the contractor for factory and on-site tests.
- (b) Test procedures for each test to be performed.

3.1.3 Detailed Commissioning plan: - 45 days before Commissioning of each location.

3.2 Report Sheet Formats

Draft formats for approval by the Employer for each type of test to be performed shall be submitted at least 60 days prior to the commencement of any test program.

3.3 Train Notices

- (a) 45 days written notice shall be given to the Employer for Provisional Acceptance Tests, so that proper train notices can be published.
- (b) 30 days notice of Putting-to-Work after acceptance of Provisional Acceptance Test.

3.4 Test Results

Results of tests performed shall be submitted on Approved Test Report Sheets accompanied by a Test Certification.

3.5 Post Commissioning Data

Employer's Requirements

- (a) 7 days after commissioning any of the works
 - (i) Voltages for all signals
 - (ii) Distribution loads at each location
 - (iii) Distribution voltages at each location
 - (iv) Drop and prevent shunt values, actual feed voltages and relay voltages of track circuits
- (b) 7 days after commissioning any of the works
 - (i) Schedules of checks carried out on point machines and signals
 - (ii) Test results for point machines and signals

4. QUALITY ASSURANCE TESTING

- (a) Testing shall only be carried out utilizing documents, plans, and diagrams etc. which have been approved by the Employer. All such documents shall be endorsed as testing copies and must not be used for any other purpose. All wiring diagrams used for testing purposes shall be of a distinctive color.
- (b) All such documentation and any other records of progress or completion of testing shall be retained and made available to the Employer / Employer's Representative.
- (c) The Employer / Employer's Representative has the right to witness all or part of the contractors test program or to appoint a Supervisor(s) who will represent the Employer during such tests.
- (d) The System Function Tests described in this section shall be carried out by the contractor under the direction and supervision of the Employer's representatives.

5. PRODUCTS

5.1 Test Program

- (a) The contractor shall prepare and submit to the Employer for his approval, a detailed test program.
- (b) Detailed methods of carrying out Unit and System functional tests shall be dependent on the precise designs of circuits and interlocking employed by the contractor. The contractor shall produce a "Testing Code of Practice" which shall establish on a test by test basis, methods of achieving the testing requirements set out in this section utilizing the circuits design.
- (c) The "Testing Code of Practice" shall be subject to the approval of the Employer and shall form the formal procedure for carrying out all functional tests.
- (d) The method of recording progress and completion of tests shall be agreed between the Contractor and the Employer.

5.2 Test Certificates

- (a) Test certificates shall be provided by the Contractor for test results other

Employer's Requirements

than "System Function Tests" in respect of the following:-

- (i) Pre-site tests for each location case, equipment room plant, control panel, signaling and telecommunications plant and cable.
 - (ii) Site tests for each signaling, power and tail cable installed.
 - (iii) Site test for each location case, or group of cases having a common identification.
 - (iv) Site tests for each equipment room.
 - (v) Site tests for all through circuits.
 - (vi) Site tests for all signals
 - (vii) Site test for all track circuits individually.
 - (viii) Site tests for all point machines individually.
 - (ix) Site tests for each control panel.
- (b) Each test report shall be headed by the identification of the place under test, type of test, test result, and a comprehensive list of wiring diagrams, including the amendment letter reference, to which the tests have been carried out. The reverse side of each test report shall be used to itemize equipment incompletely tested or untested and the reasons why the tests have not been completed.
- (c) All cable test reports shall include a list of all cable junction boxes.
- (d) All point machine test reports shall provide a record of the current and time measurements taken during the point machine tests.

5.3 Type Approval

The contractor shall submit a sample or prototype of any item of equipment, cable etc. which the Employer may require for examination and Type Approval. The Employer may additionally require, in these cases that approval of the original

Prototypes of samples shall be followed by the submission of finished items. Approval in all these respects shall be obtained before bulk manufacture commences.

6. EXECUTION

6.1 Responsibilities

- (i) The contractor shall bear all expense and provide all facilities necessary to complete the testing program, including test keyboards, testing software cables, equipment etc. in sufficient quantities to simulate all conditions. The contractor shall be responsible for wiring up the correct operation and

Employer's Requirements

dismantling all such equipment and wiring.

- (ii) The contractor shall be responsible for carrying out tests of the whole installation in accordance with the requirements of this section and any further testing that may be required.
- (iii) Where these checks and test do not indicate competent and satisfactory installation and do not indicate safe working and operation of the equipment, the contractor shall be responsible for all costs in the necessary alterations, corrections and re-test until the installation or plant satisfactorily passes all tests required by the program.

6.2 Recording

- i. Test reports shall be completed promptly on completion of the testing, or a portion of the testing. All test reports shall be submitted to the Employer for checking and approval within 15 days of completion of testing.
- ii. All test certificates shall be signed by the senior persons responsible for the work and all signatures shall be dated.

6.3 Witness

The sequence of installation and testing of the equipment by the contractor shall be such that close supervision by the Employer's staff can be carried out during installation and testing.

6.4 Retests

Completion of testing shall allow ample time for alterations to equipment to be made where required due to faulty installation or design; and it's re-testing to be carried out prior to the final commissioning of the equipment.

7. FACTORY TESTS/INSPECTION (PRE-SITE TESTING)

7.1 General

The Factory acceptance Test/Inspection (Pre-site testing) will be conducted by third party firm. Priority will be given to any firm already under contract with Pakistan Railways for this purpose.

Otherwise, an internationally reputable firm with no conflict of interest with the Contractor/Supplier will be selected. Pakistan Railways Signal Engineers will supervise and witness all testing activities. Pakistan Railways will review and approve all test results and certifications. Pakistan Railways retains the right to accept or reject the equipment based on the test outcomes. Also the quality test of all the equipment will be carried out by the firm already under contract with Pakistan Railways for this purpose or other third party which has no conflict of interest with contractor /supplier/firm. All the dues of such tests will be paid by the contractor /supplier/firm

(a) Type Approval

- i. The factory tests performed as type approval shall be a test of the contractors system and shall be performed as submitted and approved by the Employer's representative / firm. The test shall

Employer's Requirements

demonstrate the satisfactory operation of the Contractor's design before production manufacture.

(b) **Production Tests**

Factory tests shall demonstrate the satisfactory operation of all plant before shipment.

7.2 Witness

- (a) The Employer's Representative/firm representative reserves the right to witness any of the factory tests and to dispatch Employer's Representatives for these tests. The contractor will make all tools and measuring instruments, as well as the persons needed for the acceptance tests available, free of charge. All other costs shall be borne by Pakistan Railways.
- (b) If the Employer's Representative/firm representative wish to attend some of the tests, the copies of the test results will be duly certified by him after the tests have been successfully completed.
- (c) Test reports, diagrams etc. shall be clearly endorsed to show the extent of pre-site testing and its relationship to site testing. The Contractor shall ensure that the summation of pre-site and site tests produce fully tested plant in accordance with the requirements of the Specifications.
- (d) The version number of the tested CBI program and data software shall be recorded, along with full details of the associated programmable devices installed. Strict version control of software shall be maintained, and no modifications to the tested software will be permitted without the approval of the Employer.

7.3 Pre-Site Tests

- (a) **Equipment room plant**
 - (i) For the CBI and other equipment, tests shall consist of standard tests including functional test by simulation of controls and indications. As much testing as is practicable shall be carried out in this way. The version of program software and data used for the simulation shall be recorded.
 - (ii) Pre-Site tests shall also include the application of Standard Tests to wiring and cables associated with external local circuits.
 - (iii) A standard Apparatus Check, Wire Count and Bell Continuity Test shall be carried out for factory wired relay racks/groups (where applicable) and in addition the following items shall be checked:-
 - That there are no erroneous connections between wires.
 - That the insulation resistance from each wire to frame is a minimum of 1 M ohm at 500v.
- (b) **Location cases and signaling plant**

The pre-wired location cases or racks and signaling plant may be tested in the factory. Such tests shall consist of standard tests including functional test where possible. As much testing as is practicable shall be carried out in this way.

8. ON-SITE TESTING

8.1 Common Requirements

- (a) Tests on installations shall be performed in the following manner:-

Employer's Requirements

- (i) No alteration of software, circuitry or equipment which is in use regardless whether temporary or permanent shall be executed without the permission of the Employer and supervision of Railways. These operations should be entered in the logbook. The reinstatement of any temporary operations after satisfactory testing must also be entered into the logbook.
- (ii) All entries in the logbook must be countersigned by the Employer's Representative's and the contractor's representative.
- (b) The CBI installed software shall be confirmed to be of the correct version with reference to the pre-site testing software version before any on-site testing commences.
- (c) The following testing procedures shall be followed for all plant. The procedures listed under each type of plant shall be carried out in addition to visual inspection and electrical tests.

8.2 Testing Straps

Test straps used by the contractor for verifying the individual correctness of relay contacts etc. shall be limited in number and be of distinctive color each being identified by a serial number. The actual number of test straps in use at any period shall be subject to local agreement with the Employer. Test straps shall be collected and counted at the end of each days testing. The use of test lamps is not permitted. Any wiring which is to be of a temporary nature is also to be of a distinctive color.

8.3 Signaling, communication and Power Cable Tests

(a) General

Insulation and continuity tests shall be made on all cables with the addition of tests to ascertain the correct polarity of all power cabling.

(b) Records

A test report shall be completed for each cable tested. This shall contain all the information obtained during tests together with the weather at the time of the tests and any other pertinent remarks regarding conditions.

(c) Tests

- (i) For multi-core and power cables all insulations and continuity tests shall be made after their permanent installation and termination has been completed. Continuity and insulation test instruments shall be used for all tests. The voltage of the instruments shall be: 500v for all multi-core cables, 1,000v for all power cable.
- (ii) Minimum cable insulation values for multi-core and power cables shall be converted to 50 M ohms, conductor to earth, and 100 M ohms, conductor to conductor per 1 km of cable, at 20°C. Any failure to attain minimum values shall be regarded as a fault condition. The values for communication cables shall be as specified. The tests shall be carried out in the following order:-

Employer's Requirements

Verify correct size of cable conductor has been installed, Prove integrity of "TEST

EARTH SPIKE",

Test insulation between each conductor with all other conductors in the cable connected together,
Test insulation between each conductor to earth, Test continuity of each

conductor,

Check correct polarity of all power cable and

Check to ensure that each cable core is correctly terminated.

(iii) Checks shall also be made to ensure that:-

Conductors and insulation have not been damaged during stripping. Conductors are firmly held on terminals or in crimps and that terminals and links are correctly secured.

8.4 Location Cases and Racks

- (a) An Apparatus Check shall be carried out.
- (b) Bell Continuity Test shall be carried out.
- (c) Wire Count shall be carried out.
- (d) With all bus-bar fuses withdrawn from their holders, the power supply to the location shall be applied and all bus-bars tested and roughly adjusted for correct voltage values and polarity.
- (e) With all fuses and relays inserted a unit Function Test shall be carried out. This should include all local external circuits that are available.
- (f) The operation of time relays shall be checked.
- (g) As many circuits as possible shall be energized or simulated and bus-bar voltages adjusted to rated value with the mains supply at nominal voltage. Due account shall be taken if the mains supply is not a nominal voltage. Using an ohm-meter, bus-bars shall be checked free of earth.
- (h) Checks shall be made to ensure that each power supply is not connected to any other power supply.
- (i) The following checks of location cases/racks and apparatus shall be carried out:-
 - (i) The numbers on the front of the location shall be checked.
 - (ii) Location cases and racks shall be checked for corrosion and other physical damage, that the doors move freely, that door stops and fasteners work correctly, that cases are securely bolted to their bases, that the cases are mounted vertically and are not infringing standard clearances, that ventilation is adequate and that a retaining wall is not required.

Employer's Requirements

8.5 Equipment Rooms

- (a) A standard Apparatus check shall be carried out and in addition a check shall be made to ensure that all relay set connections are secure and that pin coding on relay sets and bases is correct.
- (b) Before electrical tests are commenced a temporary earth leakage detector shall be installed and its correct operation checked, on each set of electrically separate bus-bars. Operation of any detector shall operate an audible alarm. The detectors shall be in use throughout the testing period. In the event of an earth fault being detected all testing must cease until the fault is traced and rectified.
- (c) The following tests apply to all wiring.
 - (i) A Bell continuity test
 - (ii) Wire Count
 - (iii) With all bus-bar fuses withdrawn from their holders, power supplies shall be applied and bus-bars tested and roughly adjusted if necessary for correct voltage values and correct polarity.
 - (iv) With all fuses and relays inserted a Unit Function Test shall be carried out. This should include all local external circuits that are available.
- (d) The following tests shall apply to all circuitry including that contained in factory wired relay sets.
 - (i) The operation of all time relays.
 - (ii) All incoming track repeat circuits, point detection circuits etc. shall be wired in a temporary manner to test keyboards. Generally certain incoming circuits may be operated automatically by utilizing associated outgoing controls. The number of keyboards and their associated relays together with the method of wiring shall be subject to consultation and agreement with the Employer.
- (e) The following preliminary tests shall be carried out by the operation of control console/utilization of keyboards and observation of indications or simulated indications or indication outputs.
 - (i) Operate all points individually to normal and reverse and check correspondence of detection. Inhibit detection and check out-of-correspondence indication.
 - (ii) Operate and cancel all main and subsidiary signal routes and check correspondence of button indications route lights and point and signal indications.
 - (iii) Operate all track circuits and check correspondence of indications.
- (f) As many circuits as possible shall be energized or simulated and bus-bar voltages adjusted to rated value with the mains supply at nominal voltage. Due account shall be taken if the mains supply is not at nominal voltage. Special attention shall be paid to voltage levels on long circuits.

Employer's Requirements

-
- (g) Check shall be made to ensure that each power supply is not connected to any other power supply.
 - (h) Where supplies are duplicated the above tests shall be carried out on each supply in turn.

8.6 Signaling Power Supplies

- (a) Generally equipment and wiring for power supplies will be checked and tested in full along with all other circuits in equipment racks and locations.
- (b) Additionally tests on equipment associated with incoming supplies shall be carried out to check that:-
 - (i) No connections can exist between two different power sources.
 - (ii) The stand-by supply will cut-off effectively when the voltage on the fully loaded main supply reaches high or low limits.
 - (iii) Voltage regulation and limiting on the mains is such that over voltage to a degree that could cause damage to signaling equipment, cannot occur.
 - (iv) Currents taken at the principal supply points are generally in accordance with the connected loads.
 - (v) Meter scales, ratings and types of switchgear, fuses, transformers and rectifiers are correct and that all spare fuses are available.
 - (vi) Permanent labeling of equipment and HIGH VOLTAGE WARNING labels are correct.
 - (vii) Supplies are "earth free"
 - (viii) The polarity of supplies is correct.
 - (ix) The metal cases of transformers, rectifiers and power cubicles are series bonded and earthed.
 - (x) Stand-by power supplies have been tested in accordance with manufacturer's recommendations.
- (c) The cabling and apparatus used to convert the incoming power to other voltages and frequencies and subsidiary power feed bus-bars shall be checked, as far as is appropriate against the above items. The operation of duplicate transformers and transformer rectifiers shall also be checked.
- (d) Bus-bar voltage shall also be checked and adjusted where necessary having regard to the proportion of the final load connected.
- (e) Power supply distribution voltages on the feeders shall be checked to ensure that they are within the limits specified having due regard to the proportion and distribution of the load.

8.7 Through Circuits

Employer's Requirements

- (a) Where possible all tests for each through circuit should be carried out as a single operation from the point of control to the point of operation/indication.
- (b) All through circuits shall be tested as follows:-
 - (i) Energize the circuit throughout its entire length.
 - (ii) Disconnect and replace circuit fuse and in turn disconnect and replace each link and contact at every place where controls are inserted in the circuits, also at places where the circuit begins and ends, observing that the final relay/equipment responds in each case.
- (c) For polarized circuits these tests must be carried out for each polarity.
- (d) Where circuits are in cascade, e.g. cut sections, the links in the controlling relay must also be disconnected and replaced and the relay under test observed to respond.

8.8 Signals

Employer's Requirements

- (a) A standard Apparatus Check shall be carried out and in addition the following items shall also be checked:-
 - (i) Signal identification plates.
 - (ii) Signal profile.
 - (iii) Special and short range lenses fitted correctly.
 - (iv) Sight screens.
 - (v) Lens hood.
 - (vi) Subsidiary signal lenses correctly angled.
 - (vii) Main signal aligned correctly.
 - (viii) Lens and door gaskets, hinges and wing nuts and padlocks move freely and lightly oiled.
 - (ix) Lenses and front glasses clean.
 - (x) LED correct rating and type.
- (b) A Wire Count, Bell Continuity Test, and Unit Function Test shall be carried out on all circuitry not previously covered by equipment room, location, or cable testing. This shall include testing and observing the illumination of each signal aspect including subsidiary aspects and junction route indicators in turn.
- (c) In addition the bidders shall propose the tests to prove proper function of LED type signals, failure levels confirmation, visual and audible alarms etc.

8.9 Track Circuits

- (a) A standard Apparatus check shall be carried out and in addition the following items shall be checked:-
 - (i) Limits of track circuits, position of insulated joints, point and other insulations and rail-jumpers to the bonding plan etc.
 - (ii) All rail bonds including bonds in points, crossings and check rails.
 - (iii) Connections to rail secured and terminated.
 - (iv) Trackside boxes and equipment for corrosion and other physical damage, are securely mounted, and cables and wires neatly and securely terminated.
 - (v) Insulated rails free from spurious bonds or earths.
- (b) A Wire Count, Bell Continuity Test and Unit Function Test shall be carried out on all circuitry not previously covered by equipment room, location or cable testing. In addition the following checks shall be made:-

Employer's Requirements

-
- (i) Ensure that the track circuits are set up in accordance with the specifications and relevant weather/ ballast conditions.
 - (ii) Ensure that the correct track relay in all cases releases with an appropriate value train shunt applied at all of the track circuit limits.
 - (iii) With neighboring track circuits energized normally, disconnect feed and ensure relay drops and relay voltage to negligible level.

Where the above checks and test cannot be completed, ensure that all equipment has been protected and as much work as possible is carried out and left in a safe condition.

- (c) As each track circuit is brought into use the following data shall be recorded on the test certificate:-
 - (i) Drop Shunt
 - (ii) Prevent Shunt
 - (iii) Voltage at Feed and receiving ends
 - (iv) Weather Conditions

8.10 Point Machines

- (a) A standard Apparatus check shall be carried out and in addition the following items shall be checked:-
 - (i) Machine is installed on correct side of track to schedule of dimensions, correct switch is normally closed, correct type of machine, point number on machine and sleeper.
 - (ii) Multiple drives, additional detectors.
 - (iii) Sleeper fixing bolts secure with nuts facing up side.
 - (iv) Nuts and fittings properly secured with split pins opened.
 - (v) Gaskets well fitted and effective, hangers, wing nuts padlock move freely and lightly oiled.
 - (vi) Rod painted and threads greased.
 - (vii) Machine and ground connections adjusted according to the relevant instruction manual.
 - (viii) Ensure all padlocks are secure.
- (b) Using a crank handle to operate the point machine, verify that a gauge of 3.5mm thick held between the switch and stock rail at a point as near as possible in line with the lock stretcher bar prevents the locking dog entering the notch in the locking stretcher. Detector blades shall be adjusted so that when a gauge 3mm

Employer's Requirements

thick is held between the switch and stock rail at the toe of the switch the detector contacts shall not make.

- (c) A Wire Count, Bell Continuity Test and Unit Function Test shall be carried out on all circuitry not previously covered by relay room, location or cable testing, including the wiring and each detector

Contact in the detection circuit. In addition the following checks shall be made:-

- (i) For multiple ended points with each point end reverse in turn and all other ends normal ensure that the detection circuits do not work.
 - (ii) Check and record on the test certificate the starting and running currents and the time taken for complete operations.
 - (iii) Ensure that snubbing (if applicable) is effective and all contacts are correctly adjusted to relevant instruction manual.
 - (iv) Check clutch setting to relevant instruction manual.
 - (v) Check correct operation of time or overload device in both directions by placing obstructions in points.
 - (vi) Ensure that local crank handles fit the relevant point machines and that the insertion of the crank handle breaks the motor circuit.
 - (vii) Ensure correct operation of earth leakage detectors, where provided utilizing a test earth rod.
 - (viii) Ensure point indicators correctly coupled.
- (d) Where the above checks and tests cannot be completed ensure that all equipment has been provided and as much work as possible has been carried out and left in a safe condition.

8.11 Signaling Console (VDU/Indication panel etc)

A standard Apparatus Check shall be carried out as per the test procedures supplied by the contractor.

8.12 Computer Based Interlocking and equipment

- i. The requirements given in different sections shall be fully adapted by the contractor where necessary, to tests applicable to CBI equipment.
- ii. These tests shall demonstrate the correct operation of the complete system for a local interlocking under maximum load conditions. Simulators shall be provided and used in respect of the CBI and trackside equipment units.
- iii. The following shall be included:- CBI
Control Console and display

Employer's Requirements

Interfaces (Object Controllers)

Electronic Field Modules, where applicable Simulated Links
to Trackside Equipment Diagnostic System and Peripherals

- iv. Where stage works are required stage works software shall be included in the test.
- v. The bidder shall provide details of his proposals for factory tests, function system test, progressive site tests, stage works and commissioning of the total system.

8.13 Block Sections

- (a) A Standard Apparatus Check shall be carried out as part of signaling Consoles as described herein.
- (b) A Unit Function Test shall be carried out to check the continuous display of Auto Block system on both sides. Track circuits, signals and all other controls/indicators for identity and correspondence shall be checked.
- (c) Tests shall be carried out in accordance with these tests for location cases and track circuits stated in clauses 8.4 and 8.9.

8.14 Communication Plant

- (a) A Unit Function Test shall be carried out on all communication plant, alarms etc.
- (b) Loop and insulation resistance between equipment terminations for each section of cable route shall be tested prior to connection of any plant and result submitted to the Employer.
- (c) The loop resistance shall be compared with the published figures for the type of cable used and any significant deviation reported to the Employer.

8.15 Key Locked Points

- (a) A Standard Apparatus Check shall be carried out and in addition the following items shall be checked:-
 - (i) Switch is locked in the correct setting.
 - (ii) Key should securely lock when inserted in the magnetic lock.

(c) A wire count, bell continuity test and unit function test shall be carried out.

8.16 Earth Electrode system

- (a) Each earth electrode system shall be tested for compliance with these specifications with an earth resistance tester or similar instrument meeting the approval of the Employer, in accordance with the manufacturer's handbook.
- (b) The test shall be carried out with the earth system disconnected.
- (c) The specified values of earth resistance as specified are required to be achieved under dry weather conditions.
- (d) Readings and soil conditions at the time for test shall be recorded on test reports and made available to the Employer.

9. COMMISSIONING

Employer's Requirements

Commissioning shall be a three stage process

- System Function Test for issue of Provisional Acceptance Certificate
- Putting-to-Work for issue of Taking-Over Certificate
- Post Commissioning for issue of the Final Acceptance Certificate

9.1 Provisional Acceptance Test

- (a) It shall be a "System Function Test".
- (b) The Provisional Acceptance Test shall be performed by the contractor after completion of permanent works at each station including relevant block sections. The contractor shall advise the Employer at least 45 days in advance of the test so that he can be represented at the test.
- (c) The following procedure shall be adopted:
 - (i) The acceptance test shall be performed by portions as agreed with the Employer. A Provisional Acceptance Certificate shall be issued for each portion after satisfactory completion of testing.
 - (ii) The Contractor shall prepare a detailed plan for testing at each station and arrangements for hand signaling and other protection shall be clearly described. The existing signaling system shall not be disconnected or disturbed.
 - (iii) Each portion to be tested will contain at least one station complete together with the block system to one adjacent station.
- (d) The Acceptance Test shall be delayed if the Contractor has not completed the training of adequate number of Railways operators, maintainers, supervisors and Engineers to adequately maintain and operate the system installed.
- (e) Provisional Acceptance Certificate shall be issued after the test if the result of the test is satisfactory. If the test results do not fully meet the requirements of these specifications, the following shall be taken into consideration:-
 - (i) If the installed system cannot be used, commissioning will be postponed. The Contractor shall improve the system and re-test the system.
 - (ii) If the defect is minor and does not affect the system operation the Provisional Acceptance Certificate will be qualified. The Contractor shall improve the system before a Final Acceptance Certificate is issued.

9.2 Commissioning and Putting-To-Work

The Commissioning Tests and the Putting-To-work of the portion tested shall take place not later than 30 days after the date of satisfactory completion of the Systems Function Test. A Provisional Acceptance Certificate has to be issued before Commissioning can commence.

Employer's Requirements

(a) Temporary Block Working

On the days scheduled for Commissioning and Putting-To-Work of the system the existing block system to one or both adjacent stations will be disabled and paper Line Clear working introduced over the affected portions until the opening of new Block System.

(b) Preliminaries

Each portion shall be commissioned and put-to-work not later than 30 days after date of passing the Systems Function Test.

- (i) Putting-To-Work shall be jointly performed by the Contractor and the Employer.
- (ii) The Contractor shall supply all staff, tools and equipment to commission the new signaling under the direct supervision of the Employer / Employer's Representative and shall also supply staff, tools and equipment as are necessary to assist the Employer / Employer's Representative to disable the existing signaling.
- (iii) The disabling of working signaling systems at station to facilitate commissioning of the Works shall be kept to an absolute minimum. The contractor shall employ advanced planning techniques, strategies, stage work methods etc to achieve this. These shall include the following where appropriate:-

- Pre-commissioning of points/signals.
- Pre-commissioning of portions of an interlocking.
- Commissioning and then restoration of portions of the Works.
- Commissioning of the Stations, Junctions etc. in stages.

The contractor shall co-operate fully in the planning and execution of such work so as to minimize interference with Railways train operations.

The Contractor shall not disable signaling facilities at any station for more than seven continuous days for the change-over work. In exceptional cases time may be increased by the Employer / Employer's Representative.

When the signaling is disabled the points shall be secured and operated in a safe manner by Railway staff.

(c) Commissioning Tests

- (i) It is required that any test of the Provisional Acceptance Test that was simulated or plant which was tested when not in its final position must be tested and pass the Systems Function Test required for that plant.
- (ii) After satisfactory completion of the tests the Signalling console and the Block System shall be operated to demonstrate the correct function of all controls and indications.
- (iii) Final testing of the Signalling and Block system requires all plant to be in the final

Employer's Requirements

position and in operating status.

(d) Taking-Over Certificate

Upon the satisfactory completion of the Commissioning Testing and demonstration, save for minor defects that do not affect the operation of the system, the authorized representative (s) of the Employer shall sign and issue the Taking-Over Certificate for that portion.

9.3 Post-Commissioning

- (a) Immediately after Putting-To-Work the de-commissioned signaling equipment will be removed.
- (b) The contractor shall rectify all the minor defects recorded and those arising during operation of the new facilities.
- (c) Should the items (a) and (b) not be completed, the Contractor shall have a further 30 days to correct the faults after which time the Employer may take action as required by the Contract Documents.

9.4 Supervision of Maintenance

After issue of the Taking-Over Certificate the contractor shall appoint reasonable number of Engineers and supervisors to supervise and help the Railways maintenance staff for trouble free operation and maintenance of new systems. The contractor shall be responsible for supervision of maintenance for two years from the date of Taking-Over by Railways of a portion.

9.5 Final Acceptance Certificate

The final acceptance will take place upon the contractor's request, on successful completion of two years Supervision of Maintenance. Final Acceptance certificate shall be issued by the Employer after examination of the installations, study of any incidents noted during the period of operation and correction by the contractor of any defects that may have been noticed and fulfilling all other conditions mentioned in the tender and contract documents. The performance of the equipment shall be ascertained on the basis of:

- 9.5.1 Compliance to specifications of components, parts, sub-system and system.
- 9.5.2 Fail safe operation.
- 9.5.3 Failure rate of equipment/cards/components which should normally be as per the data submitted by the manufacturers with the tender.
- 9.5.4 Any other criteria to ascertain the proper functioning of equipment.

10. RECORDS

In order that correct maintenance record can be provided to the Employer on completion of installation and testing of each stage, complete record shall be made by the contractor of

Employer's Requirements

any variations between the installation on site and that required to be:-

- installed as depicted on installation plans,
- installation of plant which does not adhere to proposed diagrams, and
- Alteration to circuit wiring, etc.

A record to all such variations shall be supplied by the contractor to the Employer / Employer's Representative at suitable intervals as completion of installation and testing progresses.

11. TEST RESULTS

All tests performed shall be recorded on approved Test Report sheets and shall be signed by the person conducting the test, and endorsed by the Employer's Representative witnessing the test.

12. FACTORY TESTING

12.1 Type Approval

The Contractor shall furnish plant for examination and testing within the time frame specified to prove that his design meets with requirements of the contract specification.

12.2 Standard tests

All tests such as Inspection tests, apparatus checks, Bell Continuity Tests, Wire Count, Unit Function Tests, and System Function Tests shall be carried out to ascertain the manufacturing and functioning of all the equipment as per specifications and approved design.

In addition, a factory test of the overall CBI system shall be carried out. This test shall demonstrate the correct operation of the complete system for a local interlocking under maximum load conditions. The use of simulators in respect of the CBI and trackside equipment units will be permitted.

The factory CBI system test shall include tests to prove the functionality of all aspects of the CBI system including controls, indications, interlocking, maintenance and diagnostic facilities, links to (future) CTC and trackside equipment etc.

12.2 Inspection of Plant before shipment

12.2.1 Particular attention shall be given to the following during testing/inspection:-

- (a) Completeness
- (b) Identification markings
- (c) Finishes
- (d) Solder finishes
- (e) Cable and wire connections, ground connections, ground clamps, terminal strips, and binding posts
- (f) Solder joints

Employer's Requirements

-
- (g) Cable runs between components including plugs, and receptacles
 - (h) The fit of the components in their respective positions
 - (i) Accessibility of components and parts for servicing
 - (j) Check of mounting means

12.2.2 Each pre-wired factory unit shall be covered by a test certificate bearing the "Test Date", "Type of Test", and the signature of the "Tester" with the counter-signature of the Chief Tester. The certificate will refer to the unit tested, its location in the field of installation together with such instructions that may be necessary relating to work to be done at site, if any, and any other details that may be relevant to such work.

12.2.3 Pakistan Railways may accept factory test results of the manufacturers or depute its Engineers/representative or third-party firm during the testing stage and prior to packing and shipment. The staff deputed will participate in the major tests to be carried out in the factories where signaling equipment is manufactured in order to check that its functioning is in full compliance with the Contract Specifications and with the Operational Requirements.

K. DOCUMENTATION

1. GENERAL

- 1.1 All documentation shall be in English and all symbols and abbreviations on plans and circuit diagrams shall comply with British or German standards.
- 1.2 All drawings shall be in conformity with the best drawing practice, with a scale large enough to convey information adequately.
- 1.3 All drawings and documentation specified in this section shall be submitted to the Employer for approval. Any work done or committed by the contractor before drawings and specifications are submitted for approval, or are approved by the Employer will be at the contractors own risk.
- 1.4 The contractor shall be responsible for any discrepancies, errors, or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Employer or not.

2. CONTRACT DRAWINGS

- 2.1 Within 60 days of the Contract Commencement date the Contractor shall prepare and submit for, approval a drawing control chart which lists all drawings to be prepared with their Scheduled date for submission to the Employer for approval.
- 2.2 The chart shall be updated and re-submitted each 90 days thereafter, and shall enable the detailed record of each drawing to be maintained including its number, planned and actual dates for submission, the "Approved for Construction" date, the "As Built" date and remarks columns.

The covers of all manuals shall provide the following information:

Pakistan Railways
(Name of Project)

Employer's Requirements

(Name of Manual)

(Name of Contractor)

- 2.3** Within 90 days from the date of commencement of the contract, the contractor shall commence to submit drawings to the Employer for approval.
- 2.4** The Contractor shall be responsible for preparing all drawings, specifications, calculations, and working sketches required for the whole of the work. The drawings shall be suitable for the initial manufacture, assembly, and construction & testing of the works by the contractor, for the review and approval of all drawings by the Employer and for the ongoing maintenance of the system throughout its service life. To this end the layout of the drawings and the information contained therein shall enable an easy understanding of all parts of the system and the inter-relation with all other parts of the system.
- 2.5** The following outlines the General headings of the drawings to be prepared and supplied by the contractor:-
- (a) Control Tables for Interlockings, Automatic Block Sections and Automatic Signals, Level Crossings.
 - (b) Details of Control consoles and yard display panels.
 - (c) Assembly, Erection and Adjustment Details of all Signaling Equipment.
 - (d) Signaling Arrangement and Layout Drawings showing details of all Apparatus in the field.
 - (e) Proposed Cable Route Construction Drawings.
 - (f) Individual Signal Drawings showing the General Format, Specific Position, and any Special Sighting Details of all Signals and Drawings of proposed Signal Gentries or Cantilever Structures if any.
 - (g) Separate and Individual Layout and "Focus" Drawing of each Level Crossing Warning and Protection System.
 - (h) Drawings showing the Track Circuit Bonding and Rail Joint Insulation System.
 - (i) Circuit Drawings and Diagrams showing details of Circuit Identification and numbers of wires of each terminal for each relay.
 - (j) Fuse and Terminal; Cable Termination and Core Allocation/Analysis Schedules including Circuit Identification.
 - (k) Rack Layout Drawings of Equipment Racks; location cases; Cable Junction boxes etc.
 - (l) Floor Plans of all Buildings and Rooms indicating the proposed layout of all Equipment, including Consoles, Racks, Power and Communications Equipment etc. and including full details of Overhead and Floor Ducting and Conduits.
 - (m) Mains Electric Power Systems, Switchboards and Signaling Power Distribution including all details of Loads, and Voltage Drop Calculations etc.

Employer's Requirements

- (n) Communications Systems details and Schematic Drawings, Transmission and Attenuation Calculations.
- (o) VDU maps and displays.
- (p) Software application data listings and supporting documentation.

2.6 The above listing is not exhaustive but is indicative of the extent of the contractor's responsibilities.

2.7 The contractor shall also be responsible for the preparation of all stage work and temporary drawings required for the proper execution and implementation of the works.

2.8 Signaling circuit books

2.8.1 In general the circuit diagrams shall be drawn to show complete circuits on one sheet, and to group as much as possible of the equipment in the same location on the same sheet. All circuits at a station shall be shown in entirety in the equipment room diagrams.

2.8.2 Additionally for each location an extract showing the equipment and wiring at each location shall be prepared as a separate series of drawings suitable for being kept in that location.

3. SUBMISSION AND APPROVAL

3.1 All drawings shall be delivered to the Employer within the date stated in the drawing control chart approved by the Employer. Drawings shall be submitted regularly and at a rate in accordance with the above chart to allow for satisfactory checking and return.

3.2 Failure to receive approval for drawings not submitted at reasonable periods and in accordance with the drawing control chart will not be considered sufficient excuse for extension of Contract Period.

3.3 Three white prints of each drawing shall be submitted initially to the Employer / Employer's Representative for review. Of the three copies one will be returned to the Contractor marked to show any necessary corrections, and endorsed either "Provisionally Approved", "Approved Subject to Comments" or "Not Approved".

3.4 If "Provisionally Approved" or "Approved Subject to Comments" the Contractor shall submit, or modify the drawings to incorporate the comments and submit as the case may be, three further prints in distinctive color.

3.5 The Employer / Employer's Representative will sign these prints and endorse them as "Approved for Construction", and will retain two copies and return one to the Contractor. These colored prints shall be regarded as the Master Reference of Approved and Certified drawings. If the original drawing is "Not Approved", a new drawing shall be prepared and re-submitted as three white prints until the Employer / Employer's Representative certifies them as "Provisionally approved" or "approved Subject to Comments".

3.6 Once drawings are certified as "Approved for Construction" any amendment shall be referred to the Employer / Employer's Representative and the drawings shall be resubmitted for approval.

3.7 Return of drawings submitted for approval will generally be returned within 30 calendar days of

Employer's Requirements

receipt.

4. DRAWINGS TO BE FURNISHED ON COMPLETION OF CONSTRUCTION WORKS

- 4.1** At a minimum of 4 weeks prior to testing of any section of the work, the contractor shall supply to the Employer 3 prints in a distinctive color of each system drawing (i.e.: excluding only equipment construction drawings) which will be the Employer's "Testing Copy". All testing shall be carried out by the contractor to an identical set of "Testing Drawings".
- 4.2**
- (a) On completion of testing and adjustment of the system, and prior to proceeding with the commissioning of any section of the work, the contractor shall issue to the Employer 3 bound sets of prints in a distinctive color incorporating any alterations to any drawing, diagram or circuit etc. as a result of testing.
 - (b) These drawings shall constitute a temporary "Maintenance Copy". The drawings shall include a full set of location drawings for use in the respective equipment rooms.
 - (c) A fourth set or relevant extract of these drawings shall be left by the contractor in each line-side location constrained in vermin and waterproof containers.
 - (d) These temporary maintenance copies shall be made available a minimum of 1 week prior to commissioning.
- 4.3** Within one month of commissioning of any section of the work a further 3 sets of FINAL DRAWINGS incorporating all post commissioning modifications shall be issued to the Employer. One set of these drawings shall be an opaque white plastic for use on site.
- 4.4** Within 60 days of commissioning of any section of the work the contractor shall deliver one complete set of full size drawing originals on high grade tracing film. Originals of drawings produced by CAD shall be delivered in triplicate, as computer files on high quality disks.

5. OPERATION AND MAINTENANCE MANUALS

5.1 General

- 5.1.1** Manuals and instruction booklets for all systems/equipment shall be provided at each site before testing.
- 5.1.2** Ten sets of manuals and instruction booklets shall be delivered to the Employer, not later than one month before initial commissioning.
- 5.1.3** All manuals and instruction booklets shall be fitted into strong, durable, imitation leather-covered ring binders and in a form which will readily permit replacement or addition of individual sheets.
- 5.1.4** They shall contain complete and accurate information for operating and maintaining all equipment provided by the contractor.

5.2 Operation Manuals

Employer's Requirements

- 5.2.1 The operation manual shall indicate the purpose and use of all controls and indications provided and the use of other ancillary equipment.
- 5.2.2 The operation manual shall at least contain operating and control procedures including precautions and critical points to be observed, and the interpretation of and correct response to all indications and alarms. The Railways shall assist to ensure that the references to railway documents, rules, orders, etc, are accurate and correctly represent the Railways working procedures.
- 5.2.3 Fifty copies shall then be supplied to the Railways.

5.3 Maintenance Manuals

- 5.3.1 Maintenance Manuals indicating schedule of routine maintenance work necessary to keep the system in good working order shall be supplied. This manual shall include the recommended periodic maintenance, testing and replacement of all equipment, together with details of setting up and commissioning procedure.
- 5.3.2 The maintenance manuals shall at least include the following:-
 - (a) General descriptions of all Equipment, overall design concepts and specific features of design.
 - (b) Design data for all Equipment and Systems, specifying power, voltage and current.
 - (c) Performance specifications for all Equipment stating the basis for calculations and allowable variations.
 - (d) Maintenance Instructions, including Scheduled Preventive Maintenance, Lubrication Instructions, etc., necessary to keep the system in good working order, Schedules covering tests and Inspections to be performed after various periods of operation of all equipment.
 - (e) A general description and Identification of Special Tools and Test Equipment required for maintenance.
 - (f) Settings, clearances and adjustments for all equipment including instruments for setting to work.
 - (g) Commissioning Instructions, precautions and critical points to be observed shall be emphasized as required.
 - (h) Specific, typical and usual failure diagnosis and rectification including step by step procedures and flow charts for all equipment and systems.
 - (i) Replacement parts for all equipment assemblies and subassemblies, in adequate detail for ordering, such as part name, part number, equipment serial number, manufacturer's name and address, and normal delivery time.
- 5.3.3 All manuals shall be revised within 3 months of commissioning of the first section to completely reflect in service conditions and modifications.

Employer's Requirements

5.3.4 50 copies of maintenance manuals shall be supplied to Railways.

6. WORKSHOP MANUALS

6.1 Workshop manuals shall have specifications, drawings and instructions necessary for shop repair, adjustment and measurement of equipment for all systems supplied by the contractor, together with disassembling instructions with step by step procedures to be followed and requirements for any special instructions for the equipment supplied.

6.2 20 copies of workshop manuals shall be provided to Railways.

7. RECORD OF INSTALLED EQUIPMENT

7.1 The contractor shall produce records of all equipment installed at each site or location. These records shall include the following: -

- type of equipment or subsystem;
- location identification by chainage in km;
- estimated value of each item;
- Estimated cost of installation, testing, transport, taxes etc., for each item.

7.2 Records shall be submitted at least 15 days prior to pre-commissioning of each site or location.

8. COMPUTER AIDED DESIGN (CAD)

The contractor shall as far as possible produce the Project Drawings by CAD. Files of all 'as-built' Project Drawings on high quality computer disks shall be provided.

L. REDUNDANT MATERIALS AND EQUIPMENT

- a. After completion of putting-to-work and prior to the issue of the Final Acceptance Certificate the contractor shall remove all equipment and material made redundant by the new installations.
- b. All materials and equipment made redundant by the Works shall be identified, categorized, and a list of equipment and material prepared showing type, quantity and condition and submitted to the Employer / Employer's Representative with a request for permission to remove.
- c. Upon approval, the equipment and material shall be removed, catalogued, stockpiled and delivered to Railways at a station in the project area as directed by the Employer / Employer's Representative.
- d. An inventory shall be taken of all materials and equipment made redundant by the Works and all such materials and equipment shall be listed including signals, points, wire, cable, relays, fuses, components, telephones, electronic equipment and devices, mechanical gear, rodding, rail posts etc. located at each operational room, relay room, equipment room, location case, cabin, station yard etc.
- e. The process shall be managed and supervised by a working group comprising the

Employer's Requirements

Employer's and Contractors representatives.

- f. Redundant material/equipment shall be recovered carefully to avoid any damage.
- g. The contractor shall recover all redundant material except underground cables, signal foundations and the structures of signal cables, and relay/equipment rooms.
- h. Any surplus materials to the contract requirements as supplied by the contractor shall be listed and handed over to Railways at a designated place
- i. The Contractor shall remove all protruding bolts and metal from the face of concrete foundations.

M. SPARES

1. General

- 1.1** The tender shall include a list a of capital spare parts, including prices and quantities required, for the equipment which will keep the systems in full working order for two (2) years and which shall guard against any emergency arising from failure of individual apparatus and will ensure the continued operation of the system. The spares shall be supplied prior to the commissioning of the system or part thereof.
- 1.2** The quantities to be shown on the list shall be based on the expected failure rate for the various components. Except where specified otherwise, the quantity for each item shall not be less than 5 percent of the total quantity of the same item in use in the systems, nor less than five (5) units or pieces. For consumable items with limited life, appropriate quantities will be provided.
- 1.3** The spares shall be priced separately in the appropriate schedule. The Railways reserves the right to purchase the whole or part of the spares as listed, increase or decrease the quantities and items offered additionally the total cast of the spares should be quoted in the main BOQ where this item has been listed.
- 1.4** The Contractor will be required to guarantee the availability of the spare parts, materials, equipment and other accessories installed in the project for the recommended life of equipment/parts, after take over and to give adequate notice of any item of equipment, accessory or material which is to be superseded or the manufacture discontinued within the guarantee period.
- 1.5** Where modification to design of equipment or parts is undertaken where the new equipment or part supersedes the previous design, the modification shall be such that the new part is compatible and can be substituted into the system enabling the equipment and system to continue in normal service.
- 1.6** The Contractor shall furnish to the Employer three copies of a list showing each spare item supplied; the quantity; the name of the original manufacturer; the identifying part number in the system and its application in the system and its unit price and the delivery period. The contractor shall provide legal authorization from the manufacturers that Railways may procure the spares directly from them.

Employer's Requirements

Tentative list of minimum Spares to be maintained by the Contractor is as follows:

S.No	Description	Quantity
1.	Spot cooling unit or equivalent according to system requirement	01
2.	25HZ feeding Transformer Indoor 220VAC to 220VAC 25HZ or equivalent according to system requirement	01
3.	Keyboard	02
4.	Mouse	02
5.	Fuses of different Rating(4A,6.3A,4A16mm,2A) or equivalent according to system requirement	25
6.	220VAC/24VDC 60Amp power supply or equivalent according to system requirement	02
7.	220VAC/48VDC Power supply for Rod Signal or equivalent according to system requirement	01
8.	HMI Screen for L-Xing or equivalent according to system requirement	01
9.	Shunt Signal Control Board Circuit or equivalent according to system requirement	01
10.	Shunt Signal Complete	01
11.	PLC Unit for L-Xing or equivalent according to system requirement	01
12.	Feeding Transformer 25Hz 220VAC to 3, 5, 7, 9VAC Tapping or equivalent according to system requirement	05
13.	CCME Card For Point Machine or equivalent according to system requirement	03
14.	VOR Card or equivalent according to system requirement	03
15.	Lamp Card or equivalent according to system requirement	03
16.	Matching Transformer ZPW (2000A) or equivalent according to system requirement	06
17.	SVA (Air Core Coil) or equivalent according to system requirement	06
18.	3 Phase UPS (40kva) or better according to system requirement	01
19.	UPS Fan 12VDC Model 43M 3/H or equivalent according to system requirement	01
20.	DC Breaker 65Amp or equivalent according to system requirement	01
21.	Grease Pink	50-Kg
22.	3 Phase AVR (80KVA) or better according to system requirement	01
23.	Point Machine Complete according system requirement	02
24.	Telephone Set	03
25.	Lead wire 8mm 15feet	10
26.	Jumper wire 10mm 10 Feet	15
27.	Point Machine Motor according to system requirement	02
28.	Boom Barrier 36 feet or equivalent according to system requirement	02
29.	Barrier Machine or equivalent according to system requirement	01
30.	Barrier Machine Key Box or equivalent according to system requirement	01
31.	Cat-6 Cable Coil-90-Mtr	01
32.	Indoor Transmitter for ZPW-2000 track 24VDC & 174VAC or equivalent according to system requirement	04
33.	Feeding & Receiving Unit Cover as per sample or equivalent according to system requirement	04
34.	Point Machine Limit Switch or equivalent according to system requirement	02
35.	KVM Complete set or equivalent according to system requirement	01
36.	VCS or equivalent according to system requirement	01
37.	Patch cord optic fiber 10-meter	03
38.	Starter signal 3 aspect complete	01
39.	Starter signal 2 aspect complete	01
40.	Outer signal complete	01

Employer's Requirements

41.	Home signal complete	01
42	Axle counter sensor complete in all respects	02
43.	Axle counter system's allied interfaces devices i.e. optical modem, fiber optic transceivers, feed switches (whichever is the offered solution)	02

2. TOOLS, MEASURING AND LABORATORY EQUIPMENT

- 2.1** During the course of the installation of the system the Contractor shall supply and use his own tools and measuring instruments.
- 2.2** The tools may be removed by the contractor at the end of the Contract but he shall include new and unused tools and testing instruments in the spare component and material schedule. The tools and instruments shall suit the equipment quoted and shall include any special testing equipment that may be necessary.
- 2.3** The bidder shall propose a list of all tools, measuring and test instruments recommended indicating the quantity, quality, type, catalogue, price and any other relevant information for all the equipment.
- 2.5** The Special tools and test equipment shall be supplied to the Railways one month prior to the commissioning of the first section which are required for maintenance purposes.

3. Laboratory Test Equipment and Tools

The laboratory test equipment, measuring instruments and tools shall consist of all equipment necessary to enable Railways to perform the levels of maintenance defined in Chapter N.

4. Repair maintenance centers

Additional Equipment and tools shall be provided for each repair maintenance center and shall consist of all equipment necessary for this level of maintenance.

5. CBI Design Workstations

- 5.1** A CBI design workstation shall be provided to enable Railways to carry out modifications to the CBI's for changes or expansions to the signaling layouts. The design Workstations shall allow for all such modifications to be designed checked and fully tested and the associated software produced in the appropriate media i.e. disk, CDROM or EPROM etc.
- 5.2** The equipment to be provided shall include but not be limited to all necessary computers, input terminals, simulators, displays, printers and peripheral equipment; and all worktables, cupboards, cabinets and storage equipment etc necessary for the proper operation of the facility.

6. Training / Simulation Equipment

- 6.1** Equipment operational in a simulation mode shall be provided and installed for each type of system/equipment in the model room of Pakistan Railways Academy Walton.
- 6.2** The following shall be included:-

Employer's Requirements

- (a) A CBI system to control two model stations.
- (b) Block system between two stations.
- (c) A Control console.
- (d) A Maintainers terminal and Printer.
- (e) Trackside simulator model displaying signal aspects, point operation, level crossing protection operation reflecting accurately the operation of the ground equipment and fitted with switches to enable simulation of all possible failure conditions, occupation of track circuits and movement of trains.
- (f) Communications facilities fully operational to the simulator Control console for each type of field telephone function.
- (g) Signaling equipment shall include but not limited to:-
 - Each Type of Main Signal/Junction Route Indicator/Platform Indicator/Shunt Signal
 - Point Machine
 - Track Circuit
 - Level Crossing barrier machine and control panel.
 - UPS
 - CBI Interfaces
- (h) Additional 4 Consoles for training to operators.

N. MAINTENANCE

1. The Works shall be designed and constructed so as to be wholly maintainable. Attention shall be given to adequate equipment spacing, working environment, accessibility of components, plugs, sockets, terminations etc.
2. Systems, plant and equipment together with documentation, drawing, and manuals shall be structured so as to be maintainable by the following general maintenance hierarchy:-
 - (a) **First Level Maintenance**

Technical level maintenance comprising routine/periodic activities and rectification of failures or potential failures which can be remedied by use of diagnostics and module replacement.
 - (b) **Second Level Maintenance**

Investigation and rectification, with the use of special test equipment as necessary, of such failures or potential failures, with respect to on-line or standby systems that the 1st Level Maintenance procedures have been unable to cope with.
 - (c) **Third Level Maintenance**

Off-site diagnosis and repair of modules which have been removed and replaced

Employer's Requirements

under first level or second level maintenance.

3. Comprehensive maintenance, diagnostic and fault finding facilities shall be provided with clear and concise status and failure indications. System performance/fault logging storage, display and hard copy printing facilities shall be provided for microprocessor and solid state systems.
4. To minimize Mean Time to Rectification and simplify procedures for maintenance staff, all systems and equipment shall be installed on a modular basis. Preference will be given to systems utilizing a "plug-in" method of connecting modules.
5. The bidders shall intimate the manufacturer's recommended schedule of replacement/overhauling of cards, relays, and components or whole units for all equipment such as CBI, points machines, block equipment, Power supplies etc. for the safe and proper operation.

O. POWER SUPPLY

1. GENERAL

- 1.1 Un-interrupted power supply (UPS) consisting of battery chargers and static invertors in a compact unit with external batteries shall be provided. The UPS shall be of proven design, made by well-known and reputed international manufacturer based on state of the art technology.
- 1.2 The bidders shall calculate the load as per their offered equipment and select appropriate capacity Generators, Chargers/Rectifiers, Batteries, Transformers, inverters and cables. The Load calculations shall indicate normal and estimated maximum load: - for each main power supply point; for each power feeder; for each point on the power feeder where a load is supplied. An allowance of 20% of the estimated maximum load shall be made to allow for future development. The point machines shall operate in sequence as mentioned in item 6.1 of Chapter W.
- 1.3 Standby UPS (excluding batteries) shall be provided at the station. The standby unit shall energize automatically and take over the load in case of failure of main unit.
- 1.4 3-Phase, 380V +10% -20% commercial supply is available or shall be made available at the station by Pakistan Railways.
- 1.5 Auto start diesel generators of suitable capacity shall be provided at the station as standby to the commercial power supply.
- 1.6 A control panel shall be provided in the diesel generator room with the following functions: -
 - 1.6.1 Change over from commercial to diesel generator when: -
 - a) Electric is OFF.
 - b) Any phase of commercial supply drops below 180 V.
 - 1.6.2 Sensing time for Engine starting shall be 10 sec.
 - 1.6.3 Engine to stop when voltage restores to minimum 200 V on each phase.

Employer's Requirements

1.6.4 Sensing time for stopping the Engine shall be 5 minutes.

1.6.5 The following items shall be provided on the control panel: -

- a) Voltage and current meters for all phases.
- b) Frequency meter.
- c) Power supply ON indication for each phase.
- d) Diesel generator ON indication.
- e) Auto/Manual switch.
- f) Self-diagnostics for each PCB of the control panel.
- g) Audible alarm.

1.7 The battery shall normally be on float charge.

1.8 At least 2-hours battery backup shall be provided.

1.9 Power feeding arrangements should be such that in case of fault in UPS system it should be possible to switch manually the commercial supply/diesel generator supply to feed the system (bypass switch). Bypass switch will be provided in the Power Supply equipment room with indication on control panel.

1.10 The power supply arrangement should cater for all the load requirements of Station, block signaling and level crossings in the section.

1.11 The power may be taken through underground cable of suitable size from the station for the level crossing which is near the station or Diesel generators/Solar Panels may be considered. In this case the stand-by batteries should cater for 24 hours needs of the level crossings.

1.12 The design of the offered power supply arrangements should be most economical and reliable

1.13 FUSES

1.13.1 Circuit fuses shall be the non-re-wirable indicating cartridge type, except that in equipment rooms indicating "communications" type fuses shall be used for internal circuits.

1.13.2 The circuit design shall pay due regard to minimize the number of circuits emanating from one fuse. In general individual circuits, or a common group of circuits for the individual function, shall commence from separate fuses.

1.13.3 All line circuits shall be individually fused.

1.13.4 Adequate fuse discrimination shall be provided and in general power distribution circuit breakers shall be of appropriate rating.

2. DIESEL GENERATORS

This specification covers the supply, installation and commissioning of 40 KVA, 3 Phase, 400 Volts, 50 Hz (minimum specifications) industrial type diesel generating set on continuous operation.

1. Climatic Conditions

- a. Minimum Ambient Air Temperature.....(-) 10°C
- b. Maximum Ambient Temperature & Altitude..... 55°C @ 500 meters

Employer's Requirements

-
- c. Minimum Ambient Temperature & Altitude40°C @ 1000 meters
 - d. Relative humidity.....Min 5% Max 85%
 - e. EnvironmentSandy, stormy & dusty.
 - f. The climatic conditions over a greater part of the country are extremely severe in respect of heat and dust.
2. **Diesel Engine**
- a. The four stroke diesel engine should preferably be of 1000 revolution per minute (RPM) but not exceeding 1500 RPM.
 - b. The diesel engine should be capable of giving full output 40 KVA or more through an Alternator on continuous operation on the climatic condition given vide Clause No.1 of Part-1 above (after applying all de-rating factors). OEM's certificate and detail of calculation of de-rated output of engine and alternator up to 55 °C and 1000 meter altitude to this effect would be mandatory along with quotation.
 - c. Continuous Power Rating of the engine will be evaluated as per definition given in the BSS 5514/Pt-I/1982 which is reproduced below:-

“Power which an engine is capable of delivering continuously between the normal maintenance intervals stated by the manufacturer, at stated speed and under stated ambient conditions, the maintenance prescribed by the manufacturer being carried out”.
 - d. In case, the rating of D.G Set is offered in Prime, it would be considered as 70% of Prime rating for calculation of continuous operation/rating.
3. **Fuel Tank**
- a. Skid fuel tank of suitable capacity alongwith fuel gauge indicator as an integral part shall be supplied with the D.G. set as per design of manufacturer with minimum capacity 260 liters.
 - b. Fuel tank shall also be equipped with a suitable oil level annunciator/alarm or sensing device to warn the operator that the tank contains fuel supply for less than three hours of operation of D.G. set on full load.
4. **Fuel Supply Pump**
- a. Electrically operated fuel lift pump, equipped with arrangement may be supplied separately to lift the fuel from extra drum to bed / day tank of D.G Set.
 - b. Standby manually operated fuel lift pump shall also be provided by the manufacturer for filling fuel in the skid mounted tank in case of emergency. Manually operated fuel lift pump can be provided in parallel with the main pump (One set).
5. **Engine Filters.**
- a. **Air Filter**

The air filter(s) of an engine shall be capable of effectively cleaning the intake air in the given environment.
 - b. **Lubricating (Lube) Oil Filter.**

The lube oil filters should be provided for ensuring at least 250/300 hours working of DG Set at full load without any damage to any part or equipment of an engine.

Employer's Requirements

c. **Fuel Oil Filter and Water Separator.**

The fuel filter and water Separator may be provided to ensure serving purified fuel to engine for at least 250/300 hours working.,

6. **Fuel Oil.**

The diesel engine should be suitable to operate on High Speed Diesel oil.

7. **Speed Control**

The diesel engine should be equipped with Electronic Governor/Mechanical Governor for speed regulations with auto/manual speed adjuster.

8. **Exhaust System**

The diesel engine shall be required to be provided with a flexible exhaust manifold silencer giving a vertical outlet for the burnt gasses, designed in such a manner to avoid entrance of rainwater. Exhaust manifold silencers can be accommodated outside the DG set room and burnt gasses will be exhausted through the wall.

9. **Minimum Loading**

The diesel engine should be capable of working load as minimum as 25% of the rated output without adverse effects on vital components of the engine.

10. **Cooling System**

a. **Cooling Media.**

The engine should be water cooled suitable to meet with the requirement of cooling under conditions mentioned vide Clause # 1.

b. **Radiator**

Only original radiator and radiator fan/motor including water circulation pump /system along with DG Set shall be acceptable.

c. **High Temperature Indicating Device.**

Sensing device may be provided on the radiator to indicate the temperature of radiator water and it should shut down the D.G Set in case of attaining over and above the permissible designed temperature.

d. **Low water level Indicating Device.**

Sensing device may be provided on the radiator to indicate the low level of radiator water along with acoustic alarm and tripping device.

e. **Rust Inhibitor and Coolant.**

Cooling water inhibitor / Anti-corrosive & Anti-freeze compound conforming to International environmental safety regulation may be provided. Technical Literature of recommended brand of coolant / Anti-corrosive & Anti-freeze compound may be supplied

Employer's Requirements

by successful bidder.

11. **The Engine Protection and Annunciation Equipment.**

Following vibration and shock proof gauges and instruments shall be provided on the D.G Set for monitoring the various parameters of diesel engine:-

- a. Lube Oil Pressure Gauge.
- b. High engine Temperature Gauge.
- c. Battery Charging/Discharging Ammeter.
- d. Battery Volt Meter.
- e. Hour Counter Meter.
- f. Tachometer.
- g. Cranking /Start Switch.
- h. Frequency Meter.
- i. Auxiliary Tank Fuel Gauge.

12. **Safety and Protection Devices.**

Safety and protection devices shall be provided for shut-down of the engine automatically in the event of:

- a. Low lube oil pressure.
- b. High engine temperature.
- c. Engine over speed.

13. **Starting System**

It should have the 12/24 volts lead acid battery starting system complete with self-starter battery charging generator and regulator.

14. **Battery Charger dual arrangement.**

A transformer and rectifier type static charger (with boost and float charge selection), should be supplied with every DG Set for charging engine starting batteries in addition to 12/24 volts dynamo installed on Diesel Engine. Suitable ammeters and voltmeters are required to be provided on input and output of transformer and rectifier type battery charger.

15. **Recommended Brands of Diesel Engine.**

Following makes or their equivalents with the country of origin as indicated below will be acceptable:-

S.No.	Engine Make	Origin
1.	Caterpillar	USA, U.K & Europe.
2.	Cummins	USA/UK/ Europe
3.	Perkins	U.K/Europe/U.S.A.

In case of equivalent Diesel Engine(DG Set) is offered, then the previous supply record of the offered Diesel Engine (DG Set) under similar operating conditions as mentioned in Clause No.1 & 2 must be provided.

16. **Alternator**

- a. The alternator should be of continuous rating having 1000 / 1500 RPM, H-Class insulation with an over load capacity of 10% for one hour in every twelve hours operations.
- b. The alternator shall capable of producing output of above mention clause 3, 400 volts, 3-Phase 50 Hz through four wires.

Employer's Requirements

-
- c. Alternator shall be synchronous brushless self-ventilated, self-excited, having solid state, automatic voltage regulating device.
 - d. The same criteria for deration mentioned in clause 2(d) is also applicable on Alternator.

17. **Alternator Protections.**

Following protections should be provided in the alternator:-

- a. Stator ground fault protections.
- b. Stator open circuit protection.
- c. Stator over heating protection.

18. **Automatic Voltage Regulator (AVR)**

The automatic voltage regulator (AVR) fitted on the alternator requires to be so designed that the alternator voltage should become zero under following conditions in addition to regulating the voltage as per defined parameters and design:-

- a. Over excitation.
- b. Over voltage.
- c. Under voltage.

19. **Recommended Brands of Alternator**

Following makes or their equivalents with the country of origin as indicated below will be acceptable:-

S.No.	Alternator Make
1.	Stamford Newage of UK/USA/Europe.
2.	Caterpillar USA, UK & Europe.
3.	Siemens Germany/Europe
4.	Leroy Sommer France/Europe
5.	Volvo Sweden/Europe

In case of equivalent alternator (DG Set) is offered, then the previous supply of offered alternator (DG Set) supplied and operated over Pakistan Railways Network for use in train under similar operating conditions as mentioned in Clause 1& 2, must be provided.

20. **Coupling**

The coupling of the Diesel Engine and the Alternator would be acceptable from the country of origin mentioned against the Diesel Engine/Alternator Brands.

21. **D.G Set**

Diesel Engine shall be directly coupled with AC Alternator mounted through flexible coupling on a common steel base-frame complete with accessories/auxiliaries as defined in this specification.

22. **Working Arrangements of D.G Sets in Generator Room.**

The diesel generating set should be equipped with Automatic Transfer Switch (ATS). The Automatic Transfer Switch (ATS) should have the option of Auto / Manual switch over on Wapda Supply with interlocking arrangement.

23. **Anti-Vibration Mountings.**

Employer's Requirements

The Diesel Generating Set shall be skid mounted fitted with anti-vibration mountings suitable for installation on concrete foundations in a generator room / Sites to work in the conditions mentioned in Clause – 2 of Part-I.

24. **D.G Set Control Panel.**

- a. All instruments mounted on the panel shall be capable to withstand the conditions mentioned in Clause-2.
- b. It shall also be dust proof and protected against water splashing.
- c. Control panel shall be of floor / wall mounting type. This shall be located at a suitable distance of about two to three meters from the Diesel Generating Set in a DG set room. The gauges / capillaries /meters should be of shock proof designed to indicate the status of D.G Set in the panel.
- d. The wiring of panel should preferably be fire retardant.
- e. Each D.G Set would be controlled by independent Control Panel.

25. **Incoming Control and Protection.**

a **Moulded Case Circuit Breaker**

Moulded Case Circuit Breaker of suitable rating shall be provided which may have the following features:-

- i). Short circuit release
- ii). Earth leakage release.
- iii). Instantaneous and inverse time relay.

b **Starting / Stopping.**

Manually operated / push button should be provided on the panel for starting / stopping the engine. Push button may also be provided for emergency stop.

c **Indications and Annunciation**

Following indication shall be provided on the control panel:-

- i). Low lube oil pressure.
 - ii). High engine temperature.
 - iii). Under voltage.
 - iv). Over voltage.
 - v). Bearing temperature.
 - vi). Winding faults.
 - vii). Over speed.
 - viii). Generator on load.
 - ix). Generator tripped.
 - x). Test push button may also be provided to indicate the status of indication lamp.
- d. Following measuring instruments/meters of suitable range shall be provided on the D.G. Set control panel, either separately or in single module.
- i) Ampere meter
 - ii) Frequency meter.
 - iii) Volt meter.

Employer's Requirements

-
- iv) Kilowatt meter.
 - v) KWH meter.
 - vi) Power Factor Meter
 - vii) RPM meter

26. Control and Distribution Panel.

- a. Output of the diesel generating set shall be controlled through control and distribution panel.
- b. The power feeding arrangements shall be such that it should not be able to connect the already energized line from any other sources of power supply line or lines as defined in Clause "d".
- c. Control and distribution panel shall have change over electromagnetic contactors which should be electrically interlocked to ensure that generators shall not inadvertently inter-connected or paralleled together.
- d. On the load side of the changeover magnetic contactors a dead bus sensing system should be fitted and contactor driver board shall also be connected, so that the contactor could only be closed when the respective line is dead.
- e. The line control and distribution panel should be mounted separately and provided with protective devices for over load, short circuit and earth fault, earth leakage, single phasing, under voltage and over voltage tripping along with indication lights and alarm.
- f. Panel shall be dust proof and water splash proof; it should be mounted on anti-vibration isolators to avoid jerking and jolts.
- g. All components provided in the panel shall be vibration & shock proof and able to withstand jolts and jerks.
- h. The line panel sheets should not be less than SWG 18.

27. Generator Remote Control & Monitoring.

- a. The DG set should be equipped with remote monitoring system on PC / Cell phone through license free software and free Wifi / GSM service for one year.
- b. The DG set should be able to monitor following parameters
 - i) Fuel per hour consumption measuring in liters/hour.
 - ii) Fuel remaining balance in tank measuring in liters.
 - iii) To monitor the theft of fuel through sensor.
 - iv) Low fuel level alert (Alarm/SMS).
 - v) Grid Supply (Main) Failure/Return (ON-OFF) report with date & time.
 - vi) Generator Start / Stop Reports with date & time.
 - vii) Starting battery charging / low indication alert.
 - viii) Shutdown alarms due to overdue maintenance.
 - ix) Failure alarms identify for the user.
 - x) Generate / Save / Retrieve the last year history reports for the user.

28. Tool Kits

a. Routine Maintenance Tool Kit

One set of routine maintenance tool kit shall be supplied per DG Set. Detail of tools offered/quoted is required.

b. Overhauling Tool Kit

Employer's Requirements

One set of tool kit for major overhauling shall be supplied per DG Set. Detail of tools offered/quoted is required.

29. Drawing and Manuals

- a. The successful tenderers/bidders shall supply one set per D.G Set of operation/maintenance manual, spare parts catalogues and drawings indicating the maintenance schedules to maintain the diesel engine and alternator and their auxiliaries etc in good working condition.
- b. Two sets of workshop manuals per one DG set shall be supplied by the successful bidder along with two copies of literature/manual of special tools for complete overhauling, servicing and calibrations for:
 - i). Diesel Engine.
 - ii). Fuel Injection Pump & Governor.
 - iii). Alternator
- c. Diagrams and drawing of electric control / power circuits /fuel pipeline, water pipeline and lube oil pipeline properly framed and laminated shall also be supplied one per DG Sets for displaying in DG set room by the successful bidders.
- d. Drawings showing the overall dimensions and installation mounting of D.G Sets & Panels may be supplied by the successful bidder.

30. Compliance to Specifications, BSS & IEC

The whole equipment specified above shall have to comply with the requirement of latest relevant BSS & IEC besides CEE's Specification # PR-40 KVA/D.G SET/2024.

31. SPECIFICATION OF HIGH SPEED DIESEL OIL.

S #.	Characteristics	Test Method	Specification	
			Winter (Nov-Feb)	Summer (Mar-Oct)
1.	Ash	ASTM	% Mass Max 0.01	% Mass 0.01
2.	Carbon Residue Conradson	ASTM D 189/4530	% Mass Max 0.1	% Mass Max 0.1
3.	Cold Flow Properties a). Cloud Point b). Pour Point. c). CFPP.	ASTM D 2500 ASTM 97	Deg C Max-1 Deg C Max- 6 Deg C Max-3	Deg Max 5+ Deg C Max Zero Deg C Max 3+
4.	Colour ASTM	ASTM 1500	Deg C Max 2.5	Deg C Max 2.5
5.	Corrosion, Copper Strip No.3, 100 Deg C	ASTM D 130	No.1	No.1
6.	Cetane Index	ASTM D	Min 45	Min 45
7.	Flash Point PMcc	ASTM D 93	Deg Min 66	Deg C Min 66
8.	Density at 15 Deg C	ASTM D 1298/4052	Kg/L Min 0.82 Kg/L Max 0.87	Kg/L Min 0.82 Kg/L Max 0.87
9.	Sediment	ASTM D 473	% Mass Max 0.01	% Mass Max 0.01

Employer's Requirements

10.	Sulphur	ASTM D 1552/2622/4294	% Mass Max 0.5	% Mass Max 0.5
11.	Viscosity Kinematics 40 Deg C	ASTM D 445 ASTM D 445	CST Min 1.5 CST Max 6.5	CST Min 1.5 CST Max 6.5
12.	Water	ASTM D 95	% V Max 0.05	% V Max 0.05
13.	Distillation 90% (min) Volume recovery at Deg C.	ASTM D 86	Max 365	Max 365
14.	Calorific value gross BTU/lb.		Min 19000	Min 19000

Employer's Requirements

R.S.E SPECIFICATION NO.11/BATTERIES

NICKLE CADMIUM BATTERY/CELLS FOR SIGNALLING SYSTEMS ON PAKISTAN RAILWAYS

1. TYPE

The specification covers the supply and delivery of Alkaline Cells (Individual Cells and not in Block) Nickel Cadmium type complete in all respect for Railway Signaling Equipment suitable for the following service conditions prevailing on Pakistan Railways.

2. SERVICE CONDITIONS

Minimum ambient air temperature	=	(-) 10°C
Maximum ambient air temperature	=	55°C
Altitude above sea level	=	From 0 to 2000 meters.
Humidity	=	15-100%

3. SERVICE REQUIREMENTS

The Battery/Cells shall be suitable to power the Railway Signaling requirements. These shall be put to work, on charge and discharge cycles and also on float charge. Battery/Cells are to be utilized in sets suitable for different voltages

4. SPECIFICATIONS.

The batteries shall generally conform to BSS-683 and IEC-623. Performance figures shall relate to an electrolyte temperature of 25° C. This is being taken as an average temperature, during charge and discharge through out the year.

5. CAPACITY

The Nickel Cadmium Battery/Cells when discharged continuously at 5 hours rate to 1.0 volt, across any one cell at the normal electrolyte temperature of 25° C shall give a capacity in ampere-hours as required. Battery/Cells will be of low rate (0.1 C₅A to 0.5 C₅A) discharge. The Battery/Cells shall be capable of regaining their capacity with a maximum Ampere-hour input of 140% of the discharged capacity during charging under normal working conditions. Under certain conditions, battery/cells may occasionally be discharged below 1.0 volt per cell. The battery/Cell must, therefore, be capable of discharge below 1.0 volt per cell without impairing the guaranteed life.

6. TEMPERATURE

- i) The battery/cells shall give full rated capacity at an electrolyte temperature of 25° C.
- ii) The battery/cells shall be capable of being operated continuously at an electrolyte temperature of 46.1° C and under these conditions shall give not less than 95 percent of their rated capacity.

Employer's Requirements

7. ELECTROLYTE

The Cells shall have sufficient electrolyte capacity to permit topping up at intervals of not less than three months under normal operating conditions specified above.

The electrolyte shall be a composition of potassium hydroxide (KOH) and Lithium Hydroxide (LiOH) and shall be supplied in dry powder/flakes form packed separately in airtight plastic or steel sealed containers of not more than 1 KG. It shall be optimized to give the best combination of performance, life and energy efficiency over a wide temperature range with specific reference to the temperature going as high as 55°C.

Material specification of electrolyte powder/plates shall be furnished to enable the consumer to use commercially available electrolyte in the market. Complete instructions along with electrolyte quantity for the first filling and changing of electrolyte shall also be supplied.

8. PERFORMANCE

The bidders shall furnish their full bio-data indicating amongst other things, location of their works, type of batteries manufactured full particulars of the number of batteries supplied to various Railways world over year-wise for the last ten years along with types being offered in the tender. The following brands have already been used and approved by Pakistan Railways and shall be preferred. -

SAFT/NIFE (Sweden/France), ALCAD (England), HOPPECKE (Germany).

Other brands of same or better quality may be quoted by the bidders and shall be kept under special watch and scrutiny up to final acceptance.

9. INITIAL CHARGE

The initial treatment to render the Cells fit for service shall be recommended by the manufacturer and shall be described in detail. It shall be capable of putting into operation and achieving its full capacity after filling and one initial charge. The consignment may be rejected if any selected battery/cell fails to develop the capacity guaranteed by the manufacturer after specified one initial charge.

10. PLATES

The plates shall be of first class material and workmanship and shall be free from blowholes, cracks and other imperfections. The design of the plates shall be such as to prevent the loss of conductive and active material during repeated charging/discharging and shall permit normal working expansions without buckling or fracture at the elevated operating temperatures prevailing on our system. The method of filling active material into the pockets should be such that an exact and even distribution is achieved and it should not fall in the bottom of strips due to gravity. The internal steel parts including terminal post should be of welded design.

Employer's Requirements

11. SEPARATORS

The separators between plates shall be of the best quality plastic rods/plastic perforated sheet (injection molded grid) integrating both plate edge insulation and plate separation. The separators shall allow free electrolyte circulation between electrode plates.

12. CONTAINERS

The container shall be made of polypropylene or non-aging, non-brittle, shock resistant, high impact strength, translucent plastic that can withstand the temperature of 90° C without deformation. All plastic parts of cell housing shall be jointed by welding. The electrolyte in the container shall be visible on all the four sides with maximum and minimum electrolyte levels marked. The cells shall be capable of containing adequate amount of electrolyte especially at the top of the plates so as not to require frequent topping up under high ambient temperatures.

The vent plug shall be of flip top flame arresting type.

It shall be certified by the bidder that the life of container and vent plugs will correspond to the guaranteed life of the battery under the environmental and service conditions prevailing on the system. The pole bolts shall be as short as possible.

13. INTER CELL CONNECTOR

The inter cell connector shall be of rust proof nickel-plated copper/steel and designed to carry the maximum rated current. One inter cell connector shall be supplied with each cell.

14. CONNECTOR COVERS

Connector covers of hard P.V.C. or plastic shall be provided to prevent external short-circuiting.

15. INTER BLOCK JUMPERS

These shall be made of flexible insulated cable (in suitable length) with rust proof nickel plated copper or steel terminals at both ends capable of carrying maximum rated current. One Inter Block Jumper for each 10 cells shall be supplied.

16. TERMINAL MARKERS

Positive and negative terminals of the cells shall be color identified or provided with permanent polarity markers.

17. STORAGE

Storage period of the battery cells before use shall be indicated by the bidder; however, this period shall not be less than 30 months without impairing the capacity and any damage to the cells.

18. GUARANTEE

For the guaranteed life of their batteries, the bidders would be required to enter into a contract with Pakistan Railways for warranty on the following lines: -

Employer's Requirements

If the capacity falls under 80% within 2 years of service life, the battery would be fully replaced. If the capacity falls below 70% after 2 years service life but before expiry of the half specified life, the battery would be fully replaced. If the capacity falls below 60% during the second half of certified life the battery would be replaced on prorated life basis. A decay in capacity of more than 10% per year would not be acceptable.

19. PERFORMANCE DATA

Schedule of general information and technical data shall be furnished by the bidders as per the attached Appendices A and B. This information must be complete in all respects.

20. INSPECTION AND TEST

The inspection shall be carried out to the satisfaction of the purchaser. Test certificate with results of all standard tests shall accompany each battery/cells. The inspection may be carried out in two stages, firstly at the manufacturer's site and secondly after initial treatment in the Railways.

21. PAMPHLET

Descriptive pamphlet describing the construction of the cell and other parameters must be supplied. One maintenance instructions Pamphlet for each set of cells shall be supplied.

22. TOOLS AND OTHER NECESSARY SPARES

Any special tool considered necessary for filling and maintenance of the batteries should be quoted in the tender. Following spares and tools would be provided with the battery/cells: -

1.	Topping Up apparatus	=	1 No. per 50 Cells.
2.	Hydro Meter	=	1 No. per 50 Cells.
3.	Any other special tools considered necessary for the maintenance of Cell.	=	1 No. per 50 Cells.
4.	Insulated Box spanner	=	1 No. per 12 Cells.
5.	Thermometer	=	1 No. per 50 Cells.
6.	Rubber Gloves	=	1 Pair per 12 Cells.

23. MARKING

The Cells shall be marked with the maker's Trade Mark and with its normal capacity and year of manufacture, Serial No. and Railway Contract No.

24. PROTECTION AND PACKING

The cells and fittings shall be packed in wooden packing cases of a size and strength suitable for handling and to avoid loss or damage in transit.

Employer's Requirements

APPENDIX-A

TECHNICAL AND GUARANTEED PERFORMANCE DATA

S.No.	PERFORMANCE DATA	Particulars to be filled by the bidder
1.	Make	
2.	Type of cells.	
3.	Manufacturer's type number	
4.	Overall dimensions of each cell: (Length x width x height) with filler cap closed with filler cap open	
5.	Overall dimensions of each crate.	_____mm
6.	Weight per cell complete without electrolyte	_____mm
7.	Weight per cell complete with electrolyte	_____kg
8.	Construction of positive plates	_____kg
9.	Construction of negative plates	
10.	Charge and discharge curves (Voltage V time Are to be supplied showing the performance Of the cell under the following conditions): - Discharge of cells at the 10 hours rate. Discharge of cells at the 7 hours rate. Discharge of cells at the 5 hours rate. (When plotting above curves a minimum final voltage of 1.0 volt across any one cell shall be assumed).	
11.	Electrolyte height above the top of plates	_____mm
12.	Electrolyte depth below the bottom of the plates	_____mm
13.	Electrolyte quantity required per battery set. i) Dry. ii) Wet	_____kg. _____litters
14.	Period recommended for renewal of electrolyte. Cost of electrolyte per battery set for each renewal.	_____years.
15.	Guaranteed life of the battery/cells under service conditions prevailing on Pakistan Railways.	_____year

Employer's Requirements

APPENDIX-B

S.No.	Description.	Particulars to be filled by the bidder.
1.	Internal resistance of cell fully charged at 25°C	Ohms
2.	Ampere-hour capacity at the 5 hours rate when discharge continuously to a minimum of 1.0 volts across any one cell at an electrolyte temperature of:- i) 25° C ii) 46.1° C iii) 50° C iv) 55° C	AH AH AH AH
3.	Maximum rate of charge permissible without material damage when cells are in a fully discharged condition.	Amp_____
4.	Normal charging rate.	Amp_____
5.	i) Minimum charge current at 5 hours rate ii) Maximum discharge rate without damaging the cell plates.	Amp_____ Amp_____
6.	Amperes-hour efficiency at 5,7,10 hrs. rate	%
7.	Watt-hour efficiency at 5,7,10 hours rate	%
8.	Rise in the electrolyte temperature above the ambient air temperature when the cells are tested. i) Continuously by fully charging at normal rate. ii) Discharging at the 5 hours rate. iii) At the maximum discharging rate.	____o c ____o c ____o c
9.	Maximum electrolyte temperature that the cells will withstand without damage. i) Continuously ii) for short period (to be mentioned....hrs.)	____o c ____o c
10.	Maximum electrolyte temperature at which the cells will give the following output. i) 100% ii) 95%	____o c ____o c
11.	Minimum voltage to which cells can be discharged Without any damage.	____o c
12.	The life of the cell in charge/discharge cycles. i) 30% depth of discharge (3000 cycles minimum) ____cycles ii) 40% depth of discharge (2600 cycles minimum) ____cycles	

Employer's Requirements

P. CABLES

1. GENERAL

- 1.1** The bidders must propose cables and wires used in similar installations designed for other Railway Systems and under similar constraints like climatic conditions, soil, etc.
- 1.2** It will be the responsibility of the successful bidder to calculate actual lengths and sizes of all type of cables. The Railway will not be responsible for any cable shortage due to under estimation.
- 1.3** All buried cables shall be armored.
- 1.4** All cables except tail cables shall be suitable for electrified sections.
- 1.5** The minimum life of the cable must be 25 years.
- 1.6** The cables must be termite-proof and rodent repellent and impervious to salt and chemicals found in the soil.
- 1.7** Complete literature with full details of cable offered must be attached with the tender. The type of cable offered must be underlined with red on the literature to facilitate reference and checking.
- 1.8** At least 2 pairs in Telecom cable (if used) for all the section shall be kept reserved for future use.
- 1.9** Ten percent spare conductors must be provided in all main signal and Telecom cables. The spare conductors shall be checked at the time of provisional acceptance. Any doubling of conductors, if required should be calculated in addition to 10% spare.
- 1.10** A pair for testing telephone should be kept reserved in each main cable up to the last point.
- 1.11** All cable terminals shall be the disconnect type and return bus bars shall be non-disconnect terminal type.
- 1.12** Any circuit working upto 110 volts can share the same cable provided all safety considerations are met. For circuit's requiring high voltages, individual cable should be used for each circuit.

2. MAIN OUTDOOR CABLE

Main cables shall be as per the RSE specification No 3/Cables (or better) as given below.

Employer's Requirements

3. BRANCH/TAIL CABLES

These shall be as per RSE specifications No 2/Cables (or better) as given below, except that no joints shall be acceptable in any run and it should be able to withstand heavy jerks and vibrations and its size shall not be less than 1.5 mm sq. However long, tail cables running along the track should be as per R.S.E. Specification No. 3/cables.

4. INDOOR CABLE

Indoor cable must be of standard design and size, normally used in Relay Room and location cases and shall be of 250 volts grade minimum. It shall have PE or similar insulation.

5. TELECOMMUNICATION CABLE

The telecommunication cables shall be as per RSE specification No 4/Cables (or better), specification of which are explained under in item number 12.

6. POWER CABLES

The bidder shall quote for under-ground cable to supply power to various signaling equipment. The size and the number of conductors shall be determined according to the load to be carried by the cable. The cable shall be armored PE insulated PVC sheathed. The other conditions such as for cable laying, cable life, and general are same as specified for signal and telecommunication cables. The cable shall be of 600/1000 volts grade. The armour of the cable shall not be used in any case as a neutral.

7. OTHER REQUIREMENTS: -

- 7.1 Suitable for underground laying as well as suitable for passing through RCC pipe and G.I. Pipe.
- 7.2 Anti-Corrosive, termite proof and rodent repellent.
- 7.3 Impervious to salt and Chemicals.
- 7.4 Suitable to withstand jerks and vibrations.
- 7.5 Cable drum shall be strong enough so that the cable is not damaged during loading/unloading. Each drum shall have a standard hole at the center so that it may be hanged on an axle and jacks for unrolling the cable at the time of laying.
- 7.6 The cable shall be delivered in suitable lengths to avoid unnecessary joints and each drum shall contain one continuous length of cable.
- 7.7 The ends of the cable on the drum must be properly sealed.
- 7.8 The life of the cable shall not be less than 25 years.
- 7.9 Each bidder must submit printed technical literature showing the characteristics and technical data of the cable offered.
- 7.10 The cable shall not be damaged if bent to a minimum internal radius of 6 times the over all diameter of the cable.

Employer's Requirements

8. DELIVERY REQUIREMENTS

- 8.1** The cable shall comply with the test requirement of the manufacturing specification after installation by recognized methods. It shall be capable of being bent through 90° at a radius of seven times its own diameter over the P.V.C. sheath without giving rise to departure from the test requirements of the manufacturing specification.
- 8.2** A tape on which shall be printed the name of the manufacturer and the year of manufacture at 100 mm intervals shall be placed under the PE sheath.
- 8.3** The cable shall be supplied carefully and closely wound on strong-legged drums of adequate size.
- 8.4** The drum shall be distinctly marked with:-

The name of the supplier.
The number of the drum.
An arrow denoting the direction of rolling.
- 8.5** The drum shall carry a weather proof label with the following information: -

Designation of cable.
Designation of sheath and sheath protection.
Length of cable.

9. MULTICORE SIGNAL CABLES (BRANCH/TAIL CABLES)

R.S.E SPECIFICATION No 2/CABLES

Signal Cable of suitable Size as per the system design and offered equipment, Multi Core PE Insulated, PVC sheathed Steel wire/Tape armored, over all PVC, 600/1000 V Grade.

MAKE UP CHARACTERISTICS.

- | | | |
|------------|----------------|--|
| 9.1 | Rated Voltage | 600/1000 Volts. |
| 9.2 | Conductor | The Conductor shall be solid Circular and formed from plain annealed copper complying with BS 6360. Twisted pair of conductors shall be preferred. |
| 9.3 | Insulation | The insulation shall be PE compound (or better substitute). |
| 9.4 | Identification | Cable cores (or pairs) shall be numbered or color coded for identification. |
| 9.5 | Laying Up | The cores of cable shall be laid with right hand direction of lay, where necessary non-hygroscopic fillers may be applied. |

Employer's Requirements

- | | | |
|-------------|----------------------|---|
| 9.6 | Bedding | The cable shall have an extruded layer of BS 6746 Type TM1. TM2 or Type 6 Compound complying with requirements of BS 6746. |
| 9.7 | Armour. | Wire Armour consisting of a single layer of galvanized steel wire as per BS 6346 or steel tape Armour consisting of two layers of steel strip. |
| 9.8 | Over Sheath | The over-sheath shall be black PVC complying with BS.6346 for type TM1. |
| 9.9 | Marking | As per BS.6346. |
| 9.10 | Conductor resistance | As per size of cable |
| 9.11 | Insulation | Insulation Resistance between conductors and between conductor and armor shall not be less than 50 Meg. Ohm/KM at 20° C when tested for one minute at 500 V DC. |
| 9.12 | Test Voltage | The Test Voltage shall be 3000 V A.C. r.m.s maintained at full Value for 3 minutes without break down of Insulation. |

10. SPECIFICATIONS FOR RAIL BASE CABLE

10.1 CONSTRUCTION.

- 10.1.1 Conductor Stranded, tinned copper wire (56 x 0.30 mm dia)
- 10.1.2 Inner PE Insulation, thickness approx. 1.7 mm.
- 10.1.3 Screen of 0.3 mm dia Galvanized steel wires.
- 10.1.4 Density of screen approx: 50%
- 10.1.5 Manufacture's identification thread.
- 10.1.6 Outer sheath P.V.C black, Thickness approx: 1.5 mm.
- 10.1.7 Overall diameter. 10.2 mm $\pm$ 0.5 mm.

10.2 ELECTRICAL VALUES AT 20° C.

- | | |
|---|---------------|
| 10.2.1 Conductor resistance. | 5 ohms/KM. |
| 10.2.2 Insulation Resistance | 20 M ohms/Km. |
| 10.2.3 Operating voltage (actual value) | 400 volts. |
| 10.2.4 Testing voltage (peak voltage). | 2000 V. |
| 10.2.5 Operating capacity for 50 Hz. | 280 uf/Km. |

10.3 CHEMOTECHNICAL VALUES.

- 10.3.1 For inner PE insulation and outer P.V.C. sheath, the material should comply BS-6746.
- 10.3.2 Conductor material should be as per BS-6360.

Employer's Requirements

11. MULTI CORE SCREENED UNDER-GROUND SIGNAL CABLE (MAIN CABLE)

R.S.E. SPECIFICATION NO.3/CABLES

Signal Cable of suitable Size as per the system design and offered equipment, Multi Core PE Insulated, screened P.V.C. sheathed, steel tape or wire armored, over all P.V.C. 600/1000 Volt grade for use on sections with A.C. Electric traction, 25 KV 50 Hz, Single Phase, rail return.

MAKE UP CHARACTERISTICS.

11.1	Rated Voltage	600/1000 Volts.
11.2	Conductor.	The conductor shall be solid circular and formed from plain annealed copper complying with BS 6360. Twisted pair of conductors shall be preferred.
11.3	Insulation	The insulation shall be PE compound (or better substitute).
11.4	Identification	Cable cores (or pairs) shall be numbered or color coded for identification.
11.5	Laying up	The cores of cables shall be laid with right hand direction of lay, where necessary non-hygroscopic fillers may be applied Twisted pair of conductors shall be preferred.
11.6	Bedding 1	The cables shall have an extruded layer of BS 6746 type TM1 TM2 or TYPE 6 compounds complying with requirements of BS 6746.
11.7	Screen	Copper or aluminum wire, two layers in counter direction or copper/aluminum tubing. The thickness of the conductor/tube shall be sufficient to provide reduction factor of 0.3 with field strength of 100 V/Km.
11.8	Bedding 2	The cables shall have an extruded layer of BS 6746 type TM1 TM2 or TYPE 6 compounds complying with requirements of BS 6746.
11.9	Armour	Steel tape Armour consisting of two layers of steel strip or galvanized Steel wire.
11.10	Over-Sheath	The over-sheath shall be black PVC complying with BS-6346 for TYPE TM1.
11.11	Marking	As per BS 6346.
11.12	Conductor resistance	As per size of conductor
11.13	Insulation resistance	Insulation resistance between conductors shall not be less than 100 Meg Ohm and between conductors and armour not be less than 50 Meg. Ohm/Km at 20° C when tested for one minute at 500 V DC.
11.14	Test voltage	The test voltage shall be 3000V r.m.s maintained at full value for 3 minutes without breakdown of insulation.

Employer's Requirements

12. UNDERGROUND JELLY FILLED TELECOMMUNICATION CABLES.

R.S.E. SPECIFICATION No 4/CABLES

The bidders shall quote for underground telecommunication cable of suitable size with star quad construction as per specifications given below or better. The cable shall meet the recommendations by the C.C.I.T.T. Complete specifications for the type of cable offered are to be submitted with the quotation. The cable should be suitable for use on electrified sections with 25 KV, 50 Hz, single phase, and rail return.

MAKE UP CHARACTERISTICS.

- | | | |
|-------|--|---|
| 12.1 | Conductor. | Copper, annealed, 0.6 mm dia or more as per requirements of system. |
| 12.2 | Insulation | PE |
| 12.3 | Construction | Twisted pair or quad. |
| 12.4 | Jacketing | PE |
| 12.5 | Electric Screen | Copper or aluminum tube of sufficient thickness to provide reduction factor of 0.1 with field strength of 100 V/Km. |
| 12.6 | Bedding | PE |
| 12.7 | Armoring | Two galvanized steel tapes of 0.3 mm gauge. |
| 12.8 | Overall Sheath | PE (Rodent and termite repellent suitable for saline soil). |
| 12.9 | Capacitance
Between pairs | 52 nF. +/- 3nF. Per/Km. |
| 12.10 | Di-electric strength | 3000 V. r.m.s for 2 seconds. |
| 12.11 | Resistance per KM | 62.8 ohms +/- 1 ohm/Km at 20° C for 0.6mm cable. Bidders to supply data for other cables if quoted. |
| 12.12 | Insulation resistance | Minimum 10,000 Meg Ohms/Km when tested for one minute with 500V DC Megger. |
| 12.13 | No underground joints are applicable to both signal and telecommunication cable. | |
| 12.14 | Pair/Quad Identification | Color-codes. |
| 12.15 | The jelly shall fulfill the following requirements:- | |
| | <ul style="list-style-type: none">• The jelly shall not be harmful from the viewpoint of human safety regulations and shall not have any unpleasant smell.• Visible contaminations or water is not allowed. When stored up to 50°C no oily substance shall separate from jelly. | |

Employer's Requirements

- It must be easy to wipe off the jelly from the insulated conductors. The removal of jelly shall not impair the markings on the pairs.
- There should be no deterioration of PE or other insulation or conductor or sheath because of jelly.
- Viscosity 120 cSt at 120° C.
- Drop point 70° C
- Cone penetration 30/10 mm at 25° C
- Flash point 23° C
- Dielectric constant 2.3 at 20° C.
- Volume resistivity 10 ohm cm at 100° C.

12.16 Cross talk Not less than 80 db

13. FIBER OPTIC CABLE

R.S.E. SPECIFICATION No 5/CABLES

The Bidder can quote G 652 D or better fiber optic cable for station Yards as per their equipment requirements. In case, fiber optic cable is used for Block also, the cable shall be G 652 D or better and shall include minimum 4 spare fibers but minimum of 12 Fibers.

Q. SIGNALS

1. LONG-RANGE SIGNALS

- 1.1** The long-range signals will be of the multiple unit color light type. It will include a device for attaching it to the signal post bracket with a dull black background screen. At present 50 volts, 25/25 watts standard type, double filament, equally rated pre-focused type lamps are being used. Latest LED type light units shall be quoted for this tender. The bidders shall supply the detailed technical literature, performance data and specifications for such light units.
- 1.2** LED proving is required and optical and audible warning shall be provided on the control/indication unit in case of failure of 20% of LEDs in any single array of any aspect. Signal shall be treated as dark in case of failure of 40% LEDs in any array.
- 1.3** Each color light unit will be made up of a metal housing. The ventilating device, if provided, must prevent the introduction of insects and entry of dust and must be waterproof.
- 1.4** Signal light units shall be mounted vertically, one above the other and will be assembled and adjusted at the factory, and fastened so that it cannot get out of place with respect to the focal point. The light unit should be adjustable in horizontal and vertical position with focusing facility.
- 1.5** The lenses of the optical system will be colorless, the colors of the light being obtained by means of colored LEDs.
- 1.6** The optical system should incorporate a close visibility arrangement ensuring proper deflection of the light radiated by a post-mounted signal, such as a deflecting sector in the out-side lens so positioned that driver's visibility is ensured while he is stopping close to the signal.
- 1.7** The optical system of the signals located on straight track section will not be dispersive. It must be visible in bright daylight at least from a distance of 1500 meters. It must not develop any phantom effect
- 1.8** Dispersive optical system of outer lens shall be provided on signals located on curves and on all signals controlling exit from the platform.
- 1.9** It should be possible to replace faulty units/parts easily.
- 1.10** A dull black, removable, sub-shade/hood will be attached to each light-unit case. It should not have adverse affect on the efficiency of all the close visibility arrangements of the signal.
- 1.11** Each color light unit will include a sighting device, the axis of which will be parallel to that of the optical system, enabling the parallelism of all the units of the signal as well as its correct orientation as a whole, to be checked. Sighting arrangement shall be provided with adjustable socket/units having minimum 20

Employer's Requirements

Degree horizontal and plus or minus 5 degree vertical adjustment from the horizontal.

- 1.12** The focusing/alignment apparatus used for focusing and alignment of signal lights shall be handed over to Railways by the successful bidder.
- 1.13** The color light units shall be provided with built in locking devices with sealing arrangements. A common key shall be used for all units.
- 1.14** The frame shall be attached to the post by a device properly oriented. It will be of metal suitably protected against rusting or of any other material sufficiently rigid and rustproof. All dimensions will conform to Pakistan Railway Regulations (Schedule of Dimensions for fixed structures).
- 1.15** Automatic signal light dimming arrangement shall be provided to dim the lighting of main signal aspects during low light. The operation of the dimming switching shall also switch on the lights of point/trap indicators.
- 1.16** Power feeding arrangements shall be efficient and highly reliable, well regulated and suitable for in all respects for LED type signals.
- 1.17** All colors shall conform strictly to the Association of American Railroad specifications and BS1376 for chromaticity and transmittance. The following limits are given for guidance:-
- | | | | |
|--------|-------|---------|---------|
| Red | 630nm | x=0.704 | y=0.295 |
| Yellow | 592nm | x=0.587 | y=0.411 |
| Green | 508nm | x=0.100 | y=.611 |
| White | | x=0.310 | y=0.320 |
- 1.18** The spread of the beam pattern shall be not more than $\pm 3 \frac{1}{2}^{\circ}$. Suitable beam pattern shall be adopted for proper visibility on curves.
- 1.19** All multiple aspect signal units shall be assembled and focused such that the projected light beams from all units in the same case will be parallel to each other.
- 1.20** The bidders may suggest slight variations in above specifications as per their design.

2. Shunt Signals

- 2.1** The shunt signals will be of Position Light Type LED and will display lunar white light.
- 2.2** These shall be mounted on signal posts or concrete blocks on the ground. Shunt signal mounted below main signal shall have two lights inclined in the upper left hand quadrant at 45° angle when cleared and normally two horizontal lights will be exhibited. Independent shunt signals shall also exhibit the same aspects.
- 2.3** The light units shall have 80mm maximum diameter.

Employer's Requirements

- 2.4 The aspects shall be mounted in a single case with a one-piece rear opening door with locking and sealing facility.
- 2.5 Each light unit shall be mounted in a separate compartment to eliminate the spillage of light between one compartment and another.
- 2.6 The light shall be visible in bright sunlight on an optical axis at a minimum distance of 200m and shall also provide an equal indication at short-range.
- 2.7 Individual half-hoods of minimum length 100mm shall be provided over each lens unit.

3. SIGNAL NUMBER AND IDENTIFICATION PLATES

- (a) All number and identification plates as approved by the Employer / Employer's Representative shall be with black characters on white retroreflective background.
- (b) Signal Number plates shall be overall size 200mm x 300mm x 2.6mm gauge mounted in the vertical. Appropriate size for shunt signals shall be used.
- (c) Signal Number plates shall be mounted on the main Main Signal background below the main signal aspect.
- (d) 'A' designation plates shall be separately mounted on the signal post below the main signal.

4. SIGNAL MASTS

- (a) Signal heads for all main signals shall be mounted on posts.
- (b) The tubular posts shall be carbon steel with rolled steel base plate. Concrete masts can be proposed as alternate. All the steel parts should be hot dipped galvanized.
- (c) The signal posts shall fitted with a platform enabling the maintenance staff to work on the signal and its color light units easily. A ladder giving access to this platform shall be fixed parallel to the track.
- (d) All tops of signal masts shall be fitted with caps and seals in order to avoid the ingress of water into the mast.
- (e) The posts shall be predrilled for all cable entries and all cable entries shall be fitted with cable compression glands. The main cable entry shall be below ground level via the signal foundation.
- (f) The post shall be designed such that the lowest main Signal aspect is 4.44m above rail level. The level of the top face of the signal foundation shall be at rail level.

Employer's Requirements

- (g) The access to all signal units shall be from the rear and the design of the post and mounting arrangements shall ensure this access is possible.
- (h) All signal hoods and sighting screen surrounds shall be of durable material and painted black.
- (i) The design and construction of all signal posts, fittings, signal units and foundation shall be sufficiently robust to cater for wind conditions where high wind speeds and severe gusting up to 125 km/h may occur.
- (j) Protective electrical grounding shall be provided being electrified section

5. SIGNAL GANTRIES

Where signals are required to be mounted on gantries, the general requirements as stated above for signal masts shall also apply to signal gantries where relevant and in addition the following shall apply:-

- (a) The access for ascending all gantries shall be from one side only – i.e. the safest side of the track.
- (b) Suitable access walkways shall be provided to enable maintenance of all signals to be carried out.
- (c) A clearance diagram shall be provided for each proposed gantry and associated signal heads to clearly indicate their position with respect to Railways Schedule of Dimensions.

6. POSITIONING OF SIGNALS

- 6.1** Signals shall be positioned at a pegged site to be determined by the contractor with preliminary agreement of the Employer's representative. This will in general, be at the location shown on the signaling layout plan.
- 6.2** The signals may be re-located after the survey and approval of the Employer / Employer's Representative, if it is considered necessary due to obstruction or other impediment.
- 6.3** All signals will normally be on the left hand side (as seen by the driver) of the line to which they apply.
- 6.4** Where due to a signal being obstructed the required sighting cannot be achieved, a repeater signal shall be provided in a location determined jointly by the contractor and Railways.
- 6.5** No part of the signal assembly shall normally be less than 190mm from the outside of the Railways Schedule of Dimensions. If circumstances require any relaxation of these standards then they must be individually approved by the Employer / Employer's Representative. Extension of the Railways Schedule of Dimensions as a result of super-elevation or curvature must be taken into consideration.

Employer's Requirements

6.6 Where signal structures, locations, etc., are installed in cuttings or embankments, retaining walls or stone pitching shall be built by Railways where necessary to retain the earthworks.

6.7 Where the clearances are inadequate for the placing of a standard signal structure the contractor shall provide a suitable gantry or appropriate supporting structure as approved by the Employer.

6.8 The signal position shall not be closer than 7 meters from the fouling point.

7. POINT AND TRAP INDICATORS

7.1 All trap points and the points leading from non-interlocked yard to interlocked yard as shown on yard plans, shall be fitted with point indicators.

7.2 The Point indicators shall be a signal of a circular box shape manufactured of zinc coated and painted sheet steel. The indicator shall be mechanically connected to the point and shall be rotated by 90 degrees by the travel of the point. The indicator shall have white paint and indicate white light during night on each of the two opposite sides displayed to the driver when the point is set for the straight route. It will have green paint and Green light during night on each of the two opposite sided when turned by 90 degrees for the turnout. Exiting indicators can be seen in any yard.

7.3 The trap indicators shall be the same size and shape as point indicators. The indication shall be different in that the indicator shall show Red when trap is open and green when the trap is closed.

7.4 All indicators shall be electrically lit. The type of lamp may be incandescent (or alternate), single filament, rough service and of suitable wattage.

7.5 All cables shall be installed via a terminal box.

7.6 Alternate proposal for Point and trap indicators displaying the position of points and traps with LED arrows of appropriate colors shall also be considered.

8. SIDE INDICATORS

8.1 Side indicators for displaying the divergence of the train to maximum 2 loop lines shall be provided at the station except those covered under 'Platform Indicators' below, where platform indicators shall be provided.

8.2 Side indicator of main signal size giving proper light clearly visible from outer signal shall be provided on the main Home signal units. The specifications for the light unit will be same as for main signals. However, it will display yellow aspect when route is set for respective loop and after that main yellow aspect shall clear.

8.3 It will be fitted with a bracket on the right or left side of the signal posts at the height of lower main signal aspect.

Employer's Requirements

9. PLATFORM INDICATORS

- 9.1** Platform indicators with yellow light shall be provided at large station having more than 2 loops in one direction.
- 9.2** These will be fixed on top of home signal indicating the Alphanumeric platform/line number (e.g. 3 G) on which the train is being received.
- 9.3** The indicators will lit only when route for the desired line has been set and locked and then main home signal shall be cleared.
- 9.4** The size of the indication number shall be such that it is visible from outer signal.
- 9.5** If the number is 'OFF' or disfigured due to fusing of LEDs, the main signal shall show red aspect.

10. JUNCTION INDICATORS

- 10.1** LED type short range Junction Indicators consisting of 5 lunar white lights shall be provided at junction station (Ch-A 2.2). These shall be fixed at an angle of 45° in the left or right upper quadrant on top of the starter signals to indicate the physical direction of branch line. In the case of routes diverging to both left and right the indicator shall consist of one pivot light, plus 4 lights for the diverging indication to left and right.
- 10.2** The main aspect of the starter signal shall display yellow when the route is set for the branch line and junction indicator lamps have lit up.

11. DRAWINGS

The bidder shall include drawings of all signal units, signal post and gantry construction details with the Tender.

Employer's Requirements

R. RELAYS

1. The Relays as and if used in interlocking and control circuits of the installation will be Railway Signaling safety relays with either non-proven back contacts or proven, but not make before break contacts (no change over contacts). These must conform to British, German or equivalent standards based on UIC recommendations.
2. The bidders must propose relays, already approved and used extensively by other Railways. Technical details of all relays proposed to be used shall be furnished with the tender.
3. Individual relay and/or relay groups shall be of plug-in-type. Arrangements shall be made in plug in type relays to ensure that only similar relays can be fixed during replacement. Removal of relay or relay-groups from the relay-rack shall not cause unsafe conditions.
4. All relays/groups shall be suitably tagged and identified to prevent plugging in of the wrong type.
5. Relay groups shall indicate operational condition by LED's.
6. For route locking, point operation and locking, only latched relays shall be used.
7. The interlocking relays shall be latched and shall have self-wiping contact arrangement.
8. Interlocking relays of such design shall be used that in case of power failure they shall not change contacts to give wrong indications or create dangerous conditions.
9. The types of proposed relays shall be kept to the minimum.
10. Except for track relays, all other relays shall operate on the same nominal voltage.
11. At least 10% spare contacts (minimum 1 Front and 1 Back) shall be available. Spare contact shall be wired up to connecting terminals outside the group or plug in relays unit. Spare contacts shall be available in all individual relay and the following vital Relays in a group (wired up to terminal).
12. The use of diodes in series with biased relay coils, is forbidden. Instead, relays with permanent magnets built into the relays, shall be used if biased relays are used in the circuits.
13. All vital relays must be able to withstand a test voltage of 2000V AC.
14. All the relays connected to outdoor cables and track relays, inside or outside the equipment room, shall be inherently immune to 400 volts, AC 50 HZ and energized relay should not drop when 120 volts AC is super imposed.

S. POINTS MACHINES AND DETECTORS

1. ELECTRIC POINT MACHINES

1.1 General

- 1.1.1 State-of-the-art non-trailable point machine with internal locking for main line and also with internal locking for loop lines and detection of individual switch independently shall be used. Pakistan Railways is using Point machines manufactured by Siemen's Germany, Westinghouse U.K, Alkamar Holland and Bombardier, Sweden. The bidders shall quote machines from the same manufacturers or better in quality, performance, design and workmanship. Acceptance of a type of point machine, offered under the terms of this specification, which has not been previously employed, shall be subject to the approval of Employer.
- 1.1.2 Complete details shall be supplied by the bidders for the offered machine.
- 1.1.3 In general a separate electric point machine shall be provided for each point.
- 1.1.4 The timer having 1 to 15 seconds (Adjustable time) shall be provided for each point and crossover to cut off the supply to the point's machine to save the machine from unnecessary operation.
- 1.1.5 The flasher Relay capable to give 60 flashes per minute shall be provided in the system. In big yards two flasher relays shall be used to give flashing supply. At wayside station only one flasher relay may be used to give flashing supply to the indication and control panel.
- 1.1.6 The contractor shall provide the electric point machines together with throw/lock/lock rods, independent detector rods, appropriate locking arrangement and all necessary fittings including insulated sole plates, tie plates, number plates, fixings to meet the full requirements of the layouts, and subject to the approval of the Employer.
- 1.1.7 The body of Points Machine must have robust construction, made of cast iron, capable of mounting on extended wooden sleepers by means of holding down bolts of suitable size or it should be possible to be mounted on masonry/steel structure to be fixed with the holding down bolts.
- 1.1.8 The electric point mechanism shall be self-contained and incorporate a motor, clutch to limit transmission force, retention clutch with locking gear, throw bars, detection slides, switching contacts and with the facility for manual operation. No relays or contactors shall be housed in the machine case.
- 1.1.9 Transmission assembly with friction/non-trailable clutch should be provided for slipping operation in case of obstruction.

Employer's Requirements

- 1.1.10 The point mechanism shall be designed to permit the safe transit of trains at a speed of 160 km/h in both facing and trailing direction on the straight track on 1676mm track gauge of UIC.54, 100RE, 90 RBS or 75 RBS Rails.
- 1.1.11 The machine dimensions shall be such that when the machine is fixed on the supporting bearers, no part shall infringe on the Railways Schedule of Dimensions.
- 1.1.12 The ballast shall be packed and tamped by Railways as per requirement of the contractor to provide a firm bed. Drive rods, lock rods, detector rods etc. shall be securely fitted, adjusted and secured so that operating movements are achieved, and generally centrally located between switch timbers.

1.2 Operation

- 1.2.1 With the nominal supply voltage applied to the machine the minimum throwing force of 3 kN shall be maintained during the full movement.
- 1.2.2 The stroke of point machine shall be between 94 to 160 mm (adjustable) at the toe of the switches and shall in any case have sufficient over-stroke to cater for variation in track gauge. The actual travel will be determined by the required stroke of the facing point lock mechanism.
- 1.2.3 In the "locked" position the throw bar linkage and facing point lock mechanism shall maintain the points locked in the event of a power supply failure and shall prevent the movement of the points due to vibration or external force.
- 1.2.4 A retention clutch/internal locking arrangement shall firmly hold the throw/lock bar which via the connections with the throw rods to the switches shall firmly hold the points closed.
- 1.2.5 The point machines with retention clutch shall have a minimum of 5 kN retention force.
- 1.2.6 The operating time for the complete stroke shall not exceed 5 seconds when the points are in a well maintained condition.
- 1.2.7 The operation and detection circuits of Point machines shall have separate wires in case D.C detection is used.. The detection voltage shall be fed from outside (double cut through independent power supply).
- 1.2.8 The detection contacts of Point machine should close (Normal/Reverse) after ensuring that the internal locking arrangement has locked the switches in the desired position.
- 1.2.9 The position of the closed switch point blade shall be detected within limits.
- 1.2.10 Point blades which sit or move beyond the admissible limits from their end position shall open the detector contact.

Employer's Requirements

1.3 Manual Operation

- 1.3.1 In case of an Emergency, the Station Master is required to operate the points manually by hand cranking. It shall therefore, be possible to set a route and clear relevant signals after ensuring the setting and locking of the points in the desired direction.
- 1.3.2 It should be possible to operate the Points Machine with the help of hand crank in case of power failure. A voltage cutout switch should be provided which disconnects power supply when hand crank is inserted to operate the points machine manually. The inlet for hand crank of the machine should remain normally locked and can only be opened by S.M's control key. (.S.M's key for manual operation of points and the S.Ms key for control of operating panel are two different keys).
- 1.3.3 At way side station at least two such hand cranks shall remain in a key locked box, which shall be in the personnel custody of the Station Master.
- 1.3.4 It is preferable that hand cranks are electrically locked through Electro Magnetic locks provided in the Station Master office and released by operation of special buttons by the Station Master from the Control console.
- 1.3.5 Before setting a route over these points, the cranks must be proved in these Electro Magnetic locks.
- 1.3.6 In big yards, the hand cranks shall be locked in the Station yard at appropriate place for a group of point machines, through Electro Magnetic locks, to be released by the Station Master from Control console.
- 1.3.7 The indications for such Electro Magnetic locks shall be similar as specified for Electric key Transmitters. For this purpose, the relevant keys are to be welded with the hand cranks.
- 1.3.8 Telephone between the Station Master and the relevant location shall be provided.

1.4 Machine Case

- 1.4.1 The machine shall be enclosed in a weatherproof case with a cover which is secured by a cylinder lock arrangement and which gives free access to all internal parts for maintenance or replacement.
- 1.4.2 Gaskets and glands/packing shall be provided at all apertures to prevent ingress of rain water either directly or via moving parts. The enclosure shall be designed and finished to minimize the formation of condensation. Drainage holes shall be provided in the base of the machine casing to permit the disposal of accumulations of oil and water.
- 1.4.3 Exposed lubricating holes shall be provided with dust and weatherproof caps or covers.

Employer's Requirements

- 1.4.4 Cables shall be installed via a terminal box before entering the point machine.
- 1.4.6 Cables shall only enter the point machine housing through suitable galvanized steel conduits or by a method approved by the Employer.
- 1.4.7 Cable entries shall be gland and conveniently located for access to the outgoing terminals and also for the running of cables into the machine whether mounted for left or right hand operation.

1.5 Motor

- 1.5.1 The motor shall be of a suitable type for safe operation in both A.C. traction and non-electrified areas and shall be attached to the drive mechanism but shall be readily removable.
- 1.5.2 The cable entry to the motor shall be conveniently located and arranged so as to protect the cables from mechanical damage.
- 1.5.3 The motor shall operate at nominal voltage of 380 V A.C.
- 1.5.4 The transmission shall be so designed and constructed that the machine may be stopped, reversed or obstructed at any position during its operation without damage to the mechanism.

1.6 Wiring and Terminals

- 1.6.1 Terminals for external cable connections shall be robust, incombustible and moisture proof.
- 1.6.2 Stud type terminals are preferred and the stems shall be secured in the base of the terminal block to prevent rotation.
- 1.6.3 The terminals shall be conveniently located adjacent to the cable entry.
- 1.6.4 Internal wiring shall be double insulated from the case of the machine and shall be stranded conductor, P.V.C. insulated 1000V grade and shall be adequately rated for the electrical duty of the circuit. All wiring shall be terminated with crimp lugs with an insulation sleeve which extends over and crimps onto the outer insulation of the wire.

1.7 Electrical Detectors

- 1.7.1 The following shall apply to mechanically operated points.
- 1.7.2 The siding points/emergency cross over points equipped with a magnetic key lock shall be provided with electrical detectors. The normal, reverse and locked position of such points shall be detected and proved in signaling circuits.
- 1.7.3 The detector shall detect both switches in the case of points over which signaling movements apply in both directions and both positions of trap point over which signaled movements occur.

Employer's Requirements

- 1.7.4 The detector shall also detect the facing point lock mechanism of mechanical or hand operated facing points where facing point locks are provided.
- 1.7.5 The position of the closed switch point blade shall be detected within limits.
- 1.7.6 Point blades which sit or move beyond the admissible limits from their end position shall open the detector contact.
- 1.7.7 The actuation of the detector contacts shall be by direct mechanical means initiated and maintained by the operating mechanism.
- 1.7.8 The detector contacts shall be capable of handling currents as per circuit specifications. The contacts shall be effectively non-fusible.
- 1.7.9 The operation of the detector contacts shall be quick-acting and the contact opening shall not be less than 5 mm. The contacts shall be self-wiping.
- 1.7.10 The detector contact assemblies inclusive of any necessary contact setting adjustment facility shall be of robust construction and shall be vibration proof for the working environment.
- 1.7.11 The detector boxes and all of the arrangements associated with electrical detection must be of substantial construction, capable of withstanding considerable vibration for long periods without excessive wear.
- 1.7.12 The boxes shall be provided with closely fitted gasketed lids, suitable for securing by standard padlock, and be designed so that dirt and rain water cannot enter. The design shall be such that on removing the lid all contact surfaces and working parts are readily accessible for inspection, cleaning and adjustment. The interior of the box shall be treated to prevent the accumulation of moisture due to condensation.
- 1.7.13 Gasket arrangements, with rod shapes and packing, shall be such as to prevent the ingress of rain water where rods enter the detector. Detection circuits shall be double cut. Cable entries shall be suitably glanded.

1.8 Tolerance and Adjustment

- 1.8.1 Contact springs shall be of suitable material, of ample length and fitted with backing springs where necessary. The design shall provide for varying degree of fineness of the setting for the open and closed positions of the switch blades and shall be such that there is no tendency to cause a permanent set in the springs with a setting 6.4mm coarse.
- 1.8.2 The degree of adjustment for the contacts shall enable the setting to be adjusted so that the contact will break when a gauge 3.0mm thick is inserted between the closed switch and stock rail at the Toe of the points but not break with a 2.0mm gauge. Contacts for detection of facing point plungers must not make until the plunger is in a fully locked position.

Employer's Requirements

2. KEY LOCKED POINT.

- 2.1** At present the key locked points within signaled routes or protected areas are provided with mechanical facing point locks and operated manually either from a central lever frame or individual levers. The key for operation of these points is either electrically transmitted or is carried by the Points man for unlocking the points and then releasing the lever for reversing the points. After reversing the points, the key is locked. After completing the shunting operation, the point is put to Normal and key is extracted, thus locking the facing points in Normal position for operation of trains over these points. The key is then retransmitted to the Station Master.
- 2.2** The bidders may propose suitable arrangements for transmission of the key from the control console to the site of facing points ensuring locking and operation of such points manually through levers released remotely from the Control console.
- 2.3** Detailed description of such system shall be provided by the bidders. The system must ensure minimum safety requirements. In case the key transmitters are proposed, these shall meet the following: -
- 2.3.1 To be transmitted electrically by the Station Master from control console causing flashing of relevant point indication.
 - 2.3.2 Audible and visual alarm to be initiated at the site in the yard where these transmitters are located.
 - 2.3.3 The Points man at site shall extract the key after turning it. This shall cause the flashing point to become steady.
 - 2.3.4 The Normal position of the key (key-in) shall be displayed on the Control console in Station Master's office.
 - 2.3.5 After extracting the key, the "key-out" indication shall also appear on the console.
 - 2.3.6 Release of key should only be possible, when interlocking permits.
 - 2.3.7 The route over such points must prove that these points are locked 'Normal' and key is 'IN'.
 - 2.3.8 After completion of the shunting operation, the key shall be retransmitted after inserting and turning in the relevant key transmitter. This shall cause locking of the key immediately and initiate an Audible alarm together with flashing indication in the relevant points on the console. The Station Master shall acknowledge and re-lock the key electrically. The Station Master shall re-lock the key electrically, if the same was previously transmitted but not extracted from the magnetic lock at site.
 - 2.3.9 If at a station there are more than one such points, different type of keys are to be used at site to ensure safety.

Employer's Requirements

- 2.3.10 The magnetic key transmitter lock shall be housed in a location case of suitable size, having locking and sealing arrangement.
- 2.3.11 The magnetic key transmitter lock itself shall also have the sealing arrangement.
- 2.3.12 Such points falling in a train route, shall also be provided with electrical point detectors and Normal/Reverse indication shall be provided on the control console.
- 2.3.13 Telephone connection shall be provided between Station Master and the Points man (at site of magnetic lock).

T. CONTROL CONSOLE AND INDICATION PANEL

1. CBI

- 1.1 Control Consoles consisting of high resolution, high grade monitors, Key Board, Mouse etc. shall be provided as per the system offered for control and display of yard layout. These shall be of compact design, suitable for Table-top mounting. The operation of points, signals/routes shall be done by the operator from the console. Complete Track diagram and indications shall be available. New furniture (such as table for equipment, revolving chair(s) for operator(s), 4 sitting chairs, cupboard etc.) compatible with the new equipment for the operator room, shall also be provided by the contractor.
- 1.2 19" or larger color monitors shall be provided for display. More than one monitor can be used in case complete display is not properly visible on one monitor.
- 1.3 An indication panel (LCD or conventional) shall also be provided in addition to the monitors, behind the console and in clear view of the operator and shall depict complete Yard layout and the current status of all tracks, points, signals etc.
- 1.4 The position of points Normal or Reverse, points locked in a route and aspect of the signals shall be repeated on the monitor at the geographical location of the track diagram.
- 1.5 Normally the track diagram shall remain white when the track is clear and no route is set except for point position indicator, red signal aspect, power supply, magnetic lock, level crossing (in the yards) etc.
- 1.6 The yellow route lights shall appear when route is set from entrance to exit including overlap. The route lights between Outer and Home Signals shall automatically appear. The red indications of the track circuit occupancy will appear as per occupancy of track. On clearance of track circuit red indication shall be replaced with violet color till the route is released.
- 1.7 LED failure indication (flashing) in relevant aperture of signal shall be provided along with the audible alarm.
- 1.8 When a track circuit is occupied without route, it shall display Red.

Employer's Requirements

-
- 1.9 Manual as well as automatic (Photo cells) arrangements for dimming the signal lights shall be provided for use during night.
 - 1.10 Flashing light indication in the relevant point aperture shall be provided to indicate when points have not responded to the switch movement or when the switch and detection are out of correspondence or when point is under operation.
 - 1.11 Track circuit indication on the diagram shall be continuous.
 - 1.12 Arrangement to put signals to danger in the event of an emergency without canceling the route shall be provided.
 - 1.13 Arrangement for cancellation of a set route with appropriate time delay and with a counter to be used in emergency shall be provided. Arrangements for canceling a non-locked route shall also be provided.
 - 1.14 Indications of magnetic locks, operating switches for electrical transmission of keys or hand cranks in the geographical location of the panel, shall be provided.
 - 1.15 Arrangements shall be provided to render the console inoperative when Station Master is away temporarily. However, the route already set and locked with signals cleared, shall not be disturbed and train operation shall continue.
 - 1.16 Indication of 'Close' and 'Open' level crossing in the geographical location of the console shall be provided.
 - 1.17 All commands originated by the operator on the control console should be re-confirmed by the system and operator before execution to avoid accidental action.

2. INDICATIONS FOR THE BLOCK SYSTEM

- 2.1 The "Clear" and "occupied" indications and Axle counts for Block sections for both directions shall be displayed on the CBI monitor and Panel.
- 2.2 Wheel sensors 'alive' indication shall be provided.
- 2.3 The block indication shall flash in case train enters un-authorized in the block section from any direction. An audible alarm shall also be provided in this case and shall be cut-off by the Station Master. The flashing indication shall however, continue till the section is clear of train. This event shall be recorded.
- 2.4 The bidders shall propose additional indications and other safety related functions to be provided on the panel.

3. INDICATIONS FOR TRACK CIRCUITS

The following indication colors for track circuits are suggested: -

- 3.1 Track free - White
 - 3.2 Track Occupied - Red
- In addition to above following shall apply in the station yard.
- 3.3 Route set - Yellow

Employer's Requirements

3.4 Cleared track after Occupation - Violet

4. INDICATIONS FOR POWER SUPPLY SYSTEM

The following indications for power circuit shall be provided.

- 4.1 Commercial supply ON or OFF.
- 4.2 Diesel Generator working or not.
- 4.3 Inverter ON or OFF.
- 4.4 Battery Charge
- 4.5 Battery Discharge.
- 4.6 Additional power supply if provided, shall be indicated.
- 4.7 An audible and visual alarm shall indicate any change in indication of power arrangement. The buzzer can be stopped by Station Master.

U. LEVEL CROSSINGS

- 1.1 All the existing manned level crossing (as per list at the end of Chapter-A) in the station yard shall be interlocked with CBI. The existing interlocking arrangements for closing/opening the level crossing gates shall remain the same.
- 1.2 The gate keys shall be locked in the Electro Magnetic locks after closing the gate. These keys shall be released by the Station Master for opening the level crossing gate for road traffic. The Electro Magnetic locks shall be provided at the level crossings.
- 1.3 The following procedure is adopted for closing of level crossing:-
 - 1.3.1 Station Master will inform to gateman on telephone about the train.
 - 1.3.2 Gate man will get audible and visual alarms, showing the direction of movement of train when route setting is initiated by the Station Master.
 - 1.3.3 Gate man will close and lock the gate against road traffic.
 - 1.3.4 Two/four keys will be extracted from the gate post lock.
 - 1.3.5 These keys will then be transmitted to the Station Master through Electro Mechanical lock.
 - 1.3.6 These keys can only be released by the Station Master after the passage of train i.e. route(s) have been released or route(s) have been cancelled. This will initiate audible and visual alarm at the level crossing.
 - 1.3.7 After extracting keys from the Electro Mechanical lock, the gate man will open the gate for road traffic.
 - 1.3.8 In case the gate is closed for road traffic and another train route is set, no alarm will initiate, but visual indication shall appear showing the direction of 2nd train and keys shall remain locked till release of both routes.

Employer's Requirements

POWER OPERATED LEVEL CROSSINGS AND LIFTING BARRIERS (Optional)

1. GENERAL

- 1.1 All existing manned level crossings (as per list at the end of Chapter-A) in the yards shall be interlocked and provided with power operated lifting barriers or gate leaf interlocking where gate leaf are available, on both sides of the road.
- 1.2 A control and indication panel shall be provided in all gateman huts.
- 1.3 Audible warning arrangements and color light signals shall be provided for road users at all level crossings.
- 1.4 Telecommunications facilities with nearest Station Master shall also be provided at all the level crossings.
- 1.5 In Station Yard the Audible and Visual alarms, showing direction of movement of train shall be provided on the control panel in gateman hut, when the route is set.
- 1.6 The bidders shall also quote for complete insulated level crossing structure for all level crossings such as made of polymers. This item shall not be included in the main bid and shall be decided as a separate work, if considered feasible.

2. OPERATION

- 2.1 The operation shall be controlled by a Gate man who will raise and lower the barriers as required.
- 2.2 An audible warning shall be given to the Gate man when a train approaches and a route is set across the crossing, advising him that the crossing is to be closed. This audible warning shall continue until the barriers are lowered and are proved in the down position except in the case when a second train is coming. This audible warning will continue to sound or commence sounding when a second train is detected in the holding section.
- 2.3 The Gate man shall operate a "Down Barrier" switch which shall cause the road warning flashing red lights to operate in conjunction with the audible road warning.
- 2.4 The electric barriers shall automatically commence to be driven down electrically approximately 7 seconds later. The Gate man shall supervise the lowering of the barriers to ensure the crossing is clear of road traffic before being fully closed and he shall control the lowering of the barriers accordingly by a stop button which controls the electric motor.
- 2.5 When the barriers have been fully lowered and detected both the road audible warning and the Gate man audible warning shall be silenced, but shall recommence on detection of a second train approaching. An indication shall be given at the control panel that the crossing is closed. Main Signals controlling the approaching train(s) shall be allowed to clear.
- 2.6 In case booms of barrier break or the barrier down detection circuit fails or the barriers cannot be operated, an alternate temporary arrangement shall be provided for manual closing of level crossing for Road users. This arrangement could be a chain with a welded key on one end (or any other suitable arrangement) which shall be locked and

Employer's Requirements

turning of key shall permit the Gate man to operate a sealed button designated "Emergency Crossing Close" which shall complete the detection circuit, silence the road warning audible alarm, operate the crossing "closed" indication at the control panel and allow the Main Signals to clear and inhibit the operation of the Road signals (Red). Operation of the "Emergency Crossing Closed" button shall cause a counter to advance by one step. The Gate man audible warning shall stop.

- 2.7 Interruption of the barrier detection circuit shall cause the crossing "closed" indication to be flashed, the Road signals and main signals to replace to stop, and the Gate man audible warning to sound. The gate man shall follow the procedure for closing the crossing as per Para 2.6 above.
- 2.8 After the passage of the train the Gate man shall raise the barriers by operation of a "UP barrier" button or with manual operation. If the "Emergency Crossing Closed" switch has been operated due to failure of the barrier detection circuit/breakage of boom etc., he shall also operate a "Train Passed" push button to release the chained Key to open the crossing for Road users. "Crossing open" indication shall appear on the Control Console of the Station Master.
- 2.9 The level crossing barrier machine shall be unlocked after release of the relevant Route(s) in the station yard. The Gate man shall then be able to open the crossing for Road users.
- 2.10 An emergency operation button (normally sealed) shall be provided on the control panel to open the level crossing in case of any Emergency such as failure of track circuit, non-release of route, accidents, etc. This operation shall be registered in counter

3. MULTIPLE TRACK AREAS

- 3.1 A second train approaching a manually controlled crossing shall cause an audible warning to be given to the Gate man in conjunction with a "Second Train Coming" indication on the level crossing control panel.
- 3.2 The second train coming indication shall flash and the audible alarm shall sound until the Gate man acknowledges by operation of an "Acknowledge second Train" push button.
- 3.3 The Main Signals protecting the crossing shall not clear to proceed until the Gate man has acknowledged the second train approaching.
- 3.4 The "UP Barrier" control or the "Train Passed" control shall then be ineffective until the Gate man operates a "Second Train Passed" control.
- 3.5 Where a second train approach warning is given after the "UP Barrier" control has been initiated, the Gate man will use his judgment to re-close the crossing at an appropriate time depending on road traffic and no additional controls shall be necessary other than as for the "First Train".
- 3.6 A "Second Train Coming" signal shall operate in conjunction with an audible warning in the form of a siren.
- 3.7 The second train coming signal shall be in the form of a single flashing yellow light fitted at the rear of the road warning lights. The unit shall have a flat black background board upon which shall be inscribed "warning second train coming". The flashing yellow light

Employer's Requirements

shall operate in conjunction with the flashing lights and shall give warning to the road users that a second train is coming when the light is flashing.

- 3.8 The "Directional Arrow" signal shall operate as normal to indicate the direction of the approaching train(s).
- 3.9 A new warning cycle shall commence in case a second train approaches, after the road warning system has cleared or the boom barriers have begun to raise to open the crossing after the first train passing.

4. LIFTING BARRIER MACHINES

- 4.1 The barrier machine for Level Crossing is to be designed for operation of each barrier independently.
- 4.2 It should be of robust construction and entirely enclosed in a housing of galvanized sheet steel.
- 4.3 The machine should have two arms for fixing of booms and counter weight.
- 4.4 The barrier machine should require minimum maintenance.
- 4.5 When driving down the mechanism shall be capable of being stopped and held at any position between the vertical and horizontal. It shall also be capable of reversal in mid-stroke when driving in either direction.
- 4.6 The mechanism shall be fitted with contacts to prove that the barrier has been fully lowered, or fully raised, together with appropriate contacts for motor control.
- 4.7 If a power failure occurs while barrier is in movement the barrier stops immediately.
- 4.8 It should be possible to operate the barrier manually.
- 4.9 It should be possible to lower the barrier under the influence of gravity in the event of power failure.
- 4.10 The barrier should be mechanically locked in two end positions. It should be electrically detected for both the positions for interlocking with routes or signals and for providing indications on the panel.
- 4.11 Each Boom shall carry three pairs of red lights towards the road traffic of both directions. The lights shall be equally spaced over the length of the boom but shall be 0.5m clear of the tip. The two outer pairs of lights shall be flashed alternately. The center pair of lights shall remain steady.
- 4.12 Emergency operation for raising of barrier should be possible electrically by the joint operation of gateman and Station Master for level crossings that are in the yards.
- 4.13 The barrier machine shall be fitted with a wooden boom of 4-11 meters long. The booms shall be made in sections of maximum of 2.5 meters. Tubular steel booms can also be recommended by the bidders.
- 4.14 The design of the barrier shall be such that damage caused by collision by Road vehicles shall be limited, to the barriers only, whereas the barrier machine remains undamaged.

Employer's Requirements

-
- 4.15 Telephone communication shall be provided between the Gateman and the Station Master for station yard's level crossings and gateman and nearest Station Master in case of block section.

5. ROAD SIGNALS

- 5.1 Minimum two aspect (Red and Yellow) LED type color light signals shall be provided on a post for the road users. Two horizontal Red aspects and one Yellow aspect above the Red aspects shall be provided on both sides of the level crossing at a place from where these are clearly visible to road users.
- 5.2 The signals shall be visible from a minimum distance of 200 meters where possible.
- 5.3 When gates are open for road users, it shall display yellow aspect.
- 5.4 During warning time for approaching trains, the yellow aspect shall flash with Audible alarm.
- 5.5 When the lifting barrier starts lowering, the Red aspects shall flash and shall display as such till level crossing is closed. It shall become steady when barriers are proved closed.
- 5.6 Flashing of red signals shall be at the rate of 1.0 sec "on", 1.0 sec "off".
- 5.7 'Close' and 'Open' condition of the level crossing shall be displayed in the gateman hut along with the direction of coming train.
- 5.8 In case the level crossing is closed for road traffic, the direction arrow shall appear for an approaching train in the Station Yard or block section at gateman hut.
- 5.9 'X' arrows of 4 feet size (White and Red bands) shall be provided on the signal posts above the light units on both approach sides of the level crossing.
- 5.10 In case of failure of LEDs below allowed limit, an Audible and Visual alarm shall appear in gateman control panel.
- 5.11 The road warning signals, audible warning and road signs shall be mounted on a post constructed to the same standard as for a Main Signal but without steps.
- 5.12 The mast shall have alternate bands of yellow retro-reflecting material on a black painted background.

V. TRACK CIRCUITS

1. TRACK CIRCUITS

- 1.1 It is proposed to provide phase shift AC track circuits in the station yards based on fail safe configuration for detection of clearance/occupancy of track. Complete technical specifications, details and references shall be provided
- 1.2 Both transmitter (track feed) and receiver (track relay) shall be centrally housed in the equipment room at the station.
- 1.3 Frequencies shall be selected in such a way that electrical interference due to harmonics of traction current is not possible.

Employer's Requirements

- 1.5 Each track circuit should have independent feed unit.
- 1.6 The length of track is suggested as 400 Meters or less due to poor ballast conditions.
- 1.7 Track circuit rail connections shall be terminated on disconnection terminals for testing purposes
- 1.8 Dead sections shall be avoided.

2. TYPE OF RAILS

The rails on the running lines are of UIC54, 100 RE, 90BS, 90RBS, 75R or 75 BS type. Minimum length of cut rail is approximately 18 feet. In special cases less length can also be considered.

3. INSULATED RAIL JOINTS

- 3.1 All joints shall be of Composite Fiber or dry insulated, of a type able to withstand the high tension and compression stresses inherent in the prevailing environment in continuously welded track and shall be subject to the specific approval of the Employer. The detailed specifications and complete technical literature for the steel bars, fasteners, Insulators shall be supplied by the bidders. All machines and other items required shall be provided by the bidder. All joints shall be supplied with nuts, bolts, and iron work and end posts.
- 3.2 The joints (such as Excel/Finland, Tenconi/Switzerland, Protec/USA or equivalent) shall be suitable for continuously welded track fit for 160 Kms/hr speed and shall have long life. Detailed technical specifications shall be submitted by the bidders.

4. BONDING

Pin brazing shall be used for bonding at the rail joints with proven galvanized stranded steel wire cable of not less than 20 mm². Four Pin brazing machines and sufficient spares shall be supplied

5. BALLAST RESISTANCE

The track circuit must function correctly for ballast resistance of 1 ohm per Km. It is however pointed out that the ballast resistance goes further down during rains. The track circuit may therefore be designed for lowest value as far as possible.

6. DROP AWAY SHUNT

The drop away shunt for existing DC track circuits on Pakistan Railways is 0.4. The bidders shall suggest safe value for the approval of the Employer / Employer's Representative as per the system design.

7. DROP AWAY FACTOR

Drop away factor shall not be less than 0.7.

8. TRACK RELAYS

Employer's Requirements

The Railway Signaling safety type relays/solid state receiver unit conforming to British, German, American or equivalent standards shall be used.

9. FEED UNITS

- 9.1** Each track circuit shall be individually fed.
- 9.2** Each track circuit shall have adjustable feed resistance.
- 9.3** The connection to feed and relay ends shall be through track connection boxes by means of appropriate insulated wire ropes having at least 15 strands of 1.0 mm dia. These ropes shall be connected to the web of the rail with bolts and nuts of suitable size (directly without covering it in a pipe). However, these shall be secured with sleepers.
- 9.4** All connecting cables shall pass through G.I pipe. The G.I pipe shall be clamped with the wooden or concrete sleepers with clamps while passing under the rails.
- 9.5** All jumpers in points and crossings shall be of Rail Base cable or equivalent subject to approval of the Employer.

10. PROTECTION

The apparatus of the track circuit shall be suitably protected against affects of atmospheric stormy phenomenon by installing two lightning arrestors (non-destructive type) with fuse at relay and feed ends in each track circuit. The lightning arrestors shall operate in case surge voltage rise above 250/300 volts, as a result of atmospheric electrical discharge or in consequence of any other extraneous foreign voltages

W. ELECTRONIC INTERLOCKING

1. SYSTEM

- 1.1** Computer based interlocking shall be provided and shall be proven fully tried and tested in the service of recognized professional Railways and shall have a substantial satisfactory service history including service in locations with a similar climate to the project area.
- 1.2** Full and complete technical and operational information and details shall be included in the tender for all major components together with full service history and performance details, number of units in use etc. and identities of users with addresses, telephone and fax numbers etc. for reference purposes.
- 1.3** The tender shall include comprehensive details of such systems including the following:-
 - (a) safety philosophy utilized
 - (b) international standards applicable
 - (c) hardware, software and operational descriptions
 - (d) availability strategy and expectation
 - (e) system architecture
 - (f) evidence of acceptance and “approval for use” on one or more recognized professional Railway systems by competent authority
 - (g) service history including locations in use, length of service, references etc.

Employer's Requirements

- 1.4** The bidder shall also describe and provide, how the system caters for the following:-
- (a) Upgrading and modification
 - (b) Interfacing to the CTC system.
 - (c) Software interpretation of interlocking principles.
 - (d) Data preparation and data modification.
 - (e) Interfacing to signals, points and track circuits.
 - (f) Testing using simulators.
 - (g) Block control system.
 - (h) Technician terminal facilities.
 - (i) Maintainability and fault diagnosis.
 - (j) System self-monitoring and activity recording.
 - (k) Training requirements.
- 1.5** Real time operating system shall be adopted and processing speed shall be such that, to an operator, actions and associated responses shall appear to be virtually instantaneous making due allowance for operational times of external equipment. The bidders shall indicate the “major cycle time” for each individual CBI within which all status, interlocking, interface and ancillary functions applicable to the CBI shall be properly processed, including cross-boundary route functions in cases where an interlocking area is made up of a number of CBI units. The system shall incorporate means to permit the monitoring and display of worse case “major cycle time”. Allocation of processor systems within interlocking areas shall be designed accordingly.
- 1.6** The CBI shall comprise of dual interlocking systems operating actively redundant with one on-line and the other in hot standby mode to ensure that any single malfunction, hardware failure, disconnection, etc. shall not shut down an interlocking or any major portion of an interlocking. Status of the field conditions such as locked routes, locked points and signal aspects shall not change position during switch over. Each Interlocking system shall have 2 out of 2 configurations.
- 1.7** CENELEC (SIL-4) Railway industry standards including those applicable to the following, shall be strictly and rigorously applied:-
- (a) protection against hardware conditions creating unsafe operation
 - (b) software configuration, production, validation and version control
 - (c) independent, or evidence of independent, safety verification
- 1.8** All equipment including interfaces with the field equipment (Point machines, Signals, track circuits etc.) shall be installed in the equipment rooms.
- 1.9** All performance criteria and conditions as applicable to relay based Interlocking shall be met by the proposed CBI system.
- 1.10** The system design shall be based on Geographical or table oriented interlocking or combination of both.
- 1.11** System of signaling and interlocking will be route-interlocking system (Entrance-Exit Type).
- 1.12** The System shall have the provision for CTC operation in future with the addition of relevant CTC equipment without any modifications. The detail of such equipment along with cost shall be supplied but shall be considered as a separate item.

Employer's Requirements

- 1.13** Individual point setting should also be possible.
- 1.14** Shunt route setting and locking shall be possible.
- 1.15** It shall be possible to cancel a set and locked route with cleared signals with adjustable time delay and recorded in the counter.
- 1.16** Additional point-to-point locking shall be provided where the route is not isolated by the points and the points are leading towards the route.
- 1.17** Approach locking shall be provided on reception signals so that it is not possible to change the set and locked route. Approach locking shall also be provided on the first facing points in case the driver passes the Outer signal in Danger position so that it is not possible to operate the Point machine within the specified time.
- 1.18** For emergency operation, it should be possible to change the aspect of the cleared signal to danger. In this case the route shall remain locked and indications on the panel shall remain unchanged. This operation shall be registered in the counter.

Employer's Requirements

1.19 The functions of main signal aspects are described below: -

Signal	Aspect	Function
1.19.1 Outer Signal	Single Yellow	to receive train up to Home signal.
Outer Signal	Double Yellow	To receive train on main or loop line.
Outer Signal	Green.	Run through.
1.19.2 Home signal	Single yellow	To receive train on main line.
Home signal	Single yellow with Side indicator.	To receive train on loop line.
Home signal	Single yellow with Platform indicator.	To receive a train on respective line
Home signal	Green	Run through.
1.19.3 Main line Starter	Yellow	To allow train from main line to proceed up to Advance Starter Signal.
Main line Starter	Yellow	To dispatch the train to branch line with junction indicator up to Advance Starter Signal.
Main line Starter	Green	To dispatch a train when main line Advance Starter Signal is Green.
1.19.4 Loop line Starter	Yellow	To dispatch a train from loop line when Advance starter signal is Red, or Green.
Loop line Starter with junction Indicator	Yellow	To dispatch a train to branch line when Advance starter signal is Red or Green.
1.19.5 Shunt Signal.	Two diagonal White lights at 45°	Driver to proceed up to next shunt signal or destination track.

1.20 Normally all the signal will display red aspects.

Employer's Requirements

2. RECEPTION ROUTES

2.1 For main line Home signal

- 2.1.1 All track circuits from home signal to main line starter signal including overlap ahead of main line starter signal shall be clear. The overlap shall be up to Advance starter signals at wayside station and 180 meters ahead of Starter Signal at junction/big yards. In case of more than one overlap for a route, it will be decided by the operator (as per his requirements) which of the overlaps will be used in start - exit operation type of interlocking.
- 2.1.2 All points for the route shall be correctly set and locked.
- 2.1.3 Isolation points shall be set and locked and all points leading towards the set route shall also be locked Normal.
- 2.1.4 Conflicting routes must be checked in normal position and conflicting signals should be proved Red.
- 2.1.5 A shunt route falling in the main route must be proved Normal.
- 2.1.6 Level crossing gates (if any) should be locked for road traffic.
- 2.1.7 In case the home signal is yellow, the route must prove the relevant Starter Signal aspect as Red or Yellow.
- 2.1.8 In case the Home signal is Green, it must prove that Starter and Advance Starter Signals are Green.
- 2.1.9 The station where platform indicators are provided, the Number of the Platform and Goods/Passenger Yard indicators (G) shall be proved lit. (minimum disfiguring to avoid confusion).

2.2 For loop line Home signal with overlap towards sand hump.

- 2.2.1 Main line home signal and side indicator shall be Yellow or if Platform indicator is provided, it must display the Line Number.
- 2.2.2 All track circuits including overlap (towards Sand Hump or Siding) ahead of loop line starter signal, shall be clear.
- 2.2.3 All points for the route shall be correctly set and locked.
- 2.2.4 Isolation points shall be set and locked and all points leading towards the set route shall also be locked Normal.
- 2.2.5 Conflicting routes must be checked in normal position and conflicting signals should be proved Red.
- 2.2.6 A shunt route falling in the main route must be proved Normal (Pre-setting Not required).

Employer's Requirements

- 2.2.7 Level crossing gates (if any) should be locked for road traffic.
- 2.2.8 Red aspect of starter signal on which train is to be received, shall be proved.

2.3. For loop line Home signal with overlap towards main line

- 2.3.1 All track circuits including overlap (up to advance Starter Signals at wayside station and 180 meters on junction/big yards) ahead of loop line starter signal shall be clear.
- 2.3.2 All points for the route shall be correctly set and locked.
- 2.3.3 Isolation points shall be set and locked and all points leading towards the set route shall also be locked Normal.
- 2.3.4 Conflicting routes must be checked in normal position and conflicting signals should be proved Red.
- 2.3.5 A shunt route falling in the main route must be proved Normal (Pre-setting Not required).
- 2.3.6 Level crossing gates (if any) should be locked for road traffic.
- 2.3.7 Red aspect of the main line starter signal shall be proved.
- 2.3.8 The relevant Starter Signal shall be proved yellow or Red.
- 2.3.9 Main line home signal and side indicator shall be Yellow or if Platform indicator is provided, it must display the Line Number.

2.4 For Home signal (Call-On).

The Home Signal shall be provided with a position light Shunt Signal (Call-On) located below the main aspect (lower aspect). Normally this shall be dark. It shall indicate clear aspect (Two diagonal white lights) when cleared. In addition the platform indicator shall also display the relevant line number or Good Yard (G). The following conditions shall be met for clearing reception route for these signals.

- 2.4.1 Requires all track circuits clear except berthing line track circuit.
- 2.4.2 All other conditions as described for reception of a train on reception lines shall be met.
- 2.4.3 Special control command shall be provided on the Control Console which shall be executed for setting route along with the destination signal of the reception line. The signal shall clear after occupation of track circuit in rear of home signal for 30-60 sec (adjustable).
- 2.4.4 The main Home signal shall display Red aspect.

Employer's Requirements

2.5 Outer Signal

2.5.1 The Outer Signal is located at a minimum distance of 400/580 meters in rear of Home Signal. The approximate distances have been indicated in the Yard plans.

2.5.2 The following conditions shall be met for clearance of this signal: -

- Outer Green (Running Through of train).
 - All tracks between Outer and Home shall be clear.
 - Home signal shall be displaying Green.
 - Outer shall follow the aspect of Home Signal, separate route is not required to be set between Outer and Home.
- Outer Double Yellow.
 - All track between Outer and Home shall be clear.
 - The home Signal shall be Yellow or Yellow with side indicator or Yellow with platform indicator.
- Outer Single Yellow.
 - Home Signal to be proved Red.
 - The train has occupied for at least 60-120 seconds (adjustable) the approaching track circuit (about 100 meters long) in rear of outer signal.
 - The route has been set between Outer and Home signals (No pre-setting).
 - The calling operation shall be registered in counter.

2.6 Clearance of the outer signal for calling on operation (single yellow) does not require setting, proving and locking of an overlap. Only clearance of track circuit between outer and home is required, provided it fulfills other conditions for Calling-On.

2.7 The approach locking of points is time and not distance based.

3. DISPATCH ROUTES.

3.1. To dispatch train from main line

3.1.1 All track circuit ahead of main line starter signal up to Advance Starter Signal shall be clear.

3.1.2 All the points for the route shall be correctly set and locked.

Employer's Requirements

- 3.1.3 Isolation points should be proved, set and locked against the route.
- 3.1.4 Conflicting routes must be checked in normal position.
- 3.1.5 Level crossing gate if any shall be proved locked for road traffic.
- 3.1.6 For clearing the Starter Signal (Yellow), it must prove the Advance Starter Signal 'Red'. For clearing the Starter Signal to Green, the Advance Starter signal must prove as Green.
- 3.1.7 At junction station where the Starter Signals have been provided with junction indicators (Branch line indication), the junction indicator shall be proved 'lit' for clearing the Starter Signals.

3.2. To dispatch train from loop line (yellow)

- 3.2.1 All track circuit ahead of loop line Starter signal up to Advance Starter Signal shall be clear.
- 3.2.2 All the points for the route shall be correctly set and locked.
- 3.2.3 Isolation points should be proved set and locked against the route.
- 3.2.4 Conflicting routes must be checked in Normal position.
- 3.2.5 Level crossing gate if any, shall be proved locked for road traffic.
- 3.2.6 Advance starter signal shall be proved Green or Red.
- 3.2.7 The red aspect of the main line Starter Signal and all other Starter Signals leading towards this route (trailing portion) should be proved.
- 3.2.8 At junction station where the Starter Signals have been provided with junction indicators (Branch line indication), the junction indicator shall be proved 'lit' for clearing the Starter Signals.

3.4 Advance Starter Signal (Block System).

- 3.4.1 The Green aspect of the Advance Starter signal shall be controlled by the Station Master subject to the requirements of block section ahead that is Axle counter shows 'Zero' count for that direction.
- 3.4.2 The Advance starter signal shall go to RED when the first Axle passes over the wheel sensor.

3.5 Run through Route.

The run through route shall be set after setting reception and dispatch route (in either sequence) and fulfilling the conditions for clearing the Advance Starter Signal.

3.6. Shunt Routes.

These shall clear when: -

Employer's Requirements

- 3.6.1 Command for the desired route is executed.
- 3.6.2 All track circuits in the route except for the destination track are clear.
- 3.6.3 All points are set and locked. No overlap is required.
- 3.6.4 Conflicting shunt and main routes are proved Normal.
- 3.6.5 If the signal is located on the main signal post, the main signal must be proved Red.
- 3.6.6 Level crossing (if any) shall be proved locked against the road traffic.
- 3.6.7 Isolation points should be proved set and locked against the route.
- 3.6.8 The main route on the same path should be proved Normal.
- 3.6.9 Maximum possible main and shunt routes shall be provided at all station to facilitate train and shunting operation. These routes shall be approved by the Employer before installation. Any missing route shall be accommodated without any extra cost. In principal, the general arrangements of shunt routes shall be as under: -
 - 3.6.9.1 From Loco Lines to all reception lines (Passenger/Goods lines, Engine lines, Sidings, Stabling lines, Shunting necks etc. and vice versa).
 - 3.6.9.2 All Starter signals to Advance starter signals, Washing lines, Relief sidings, Shunting necks, Quarry sidings etc. and vice versa.

4. RELEASING OF ROUTES

4.1 Reception Route by passage of train

Passage of a train shall automatically restore the signal to red. It shall be sectional release of route in big yards by the passage of the train. For wayside station, sequence shall be as under. Points shall remain in their last operated position.

- The track in rear of home signal is occupied and home signal is displaying Green or Yellow.
- First track circuit ahead of Home Signal is occupied.
- Home Signal changes aspect to Red.
- Track circuit in rear of Home signal is clear and first track circuit ahead of Home signal and berthing track circuits are occupied.
- First track circuit is clear and Home signal is Red and berthing track is occupied.

Employer's Requirements

4.2 Release of Overlap

On releasing of reception route, overlap shall release automatically after time delay of 30 seconds (adjustable). In case of disturbance in sequence of release, it should be possible to release the overlap by manual operation but proving that berthing track is occupied.

4.3 Dispatch Route release

It shall be sectional release in big yards and for wayside station, the principle of sequence shall be as for reception route release except that the condition for occupation of berthing track circuit in rear of the Starter Signal is not required.

4.4 Release of Shunt Route

Same principle as for reception route except for the cases where there is only one track circuit between the shunt signal and destination track, the release of route shall be by occupancy and release of track circuit ahead of Shunt signal. It should not be possible to release a shunt route by reverse movement of vehicle(s).

4.5 Emergency Route release

4.5.1 It should be possible to cancel the set and locked route.

4.5.2 The route shall release after time lapse of 60-120 seconds (adjustable) and such operation shall be recorded in the counter.

4.6 Release of route when the signal has not been cleared due to any reason

It shall be possible to release a set and locked route in case the relevant signal has not been cleared due to any reason. Such operation shall cause immediate release of route.

5. APPROACH LOCKING

5.1 All controlled signals shall be approach locked when clear.

5.2 Main Signals shall be approach locked when clear with approach track circuit or circuits occupied.

5.3 The approach locking of Main Signals shall be released by a time delay adjustable to between 2 and 5 minutes, or by the train passing the signal and entering the route.

5.4 Subsidiary Main Signals such as Call-on and Shunt-Ahead signals shall have the same approach locking conditions and releases as the main signal.

5.5 Ground Shunting Signals shall be approach locked when cleared.

5.6 The approach locking of ground shunting signals shall be released by a time delay of 60 seconds, or by the train passing the signal and entering the route.

Employer's Requirements

6. OPERATION OF POWER POINTS

6.1 By Route Setting

Points shall be set and locked by the operation of the route setting system.

Where a route contains more than one set of points, these shall be set in sequence:-

- a) As detailed in the control tables to satisfy interlocking conditions.
- b) In order to prevent point machine switch-on surges, over-loading point power supplies, the points shall be called sequentially, separated by an adequate time interval.
- c) A maximum of 2 machines at each end of the station may be switched on together at any one time.

6.2 Individual Operation

Individual Operation of points shall be possible when the points track circuit is clear, and no route is set over them. This operation shall cause the points to assume the opposite position.

7. Control/Interlocking Tables

- 7.1 Interlocking control circuits and interlocking application data software shall be assigned in accordance with approved control tables. Sample sheet of an Interlocking table of a way side station is placed in PART-III.
- 7.2 The contractor shall produce all control tables required including all routes, automatic signals, block circuits and level crossings. It shall be the contractor's ultimate responsibility to provide accurate and fully checked comprehensive sets of control tables for the station and junctions etc. and a design for a system that is intrinsically safe and operates correctly and without danger to any person.
- 7.3 The control tables shall be prepared and submitted for final approval in accordance with an agreed schedule, the first station being submitted for approval within 90 days of award of Contract and thereafter in accordance with the agreed schedule

8. VITAL LOCKING

- 8.1 Interlocking shall be provided between all conflicting routes. Direct locking shall be applied between opposing signals. All locking shall be continuously proved. Initial locking shall be maintained until the route concerned is released.
- 8.2 Conflicting routes which require points in opposite positions may be interlocked indirectly via the points.
- 8.3 Set routes shall back lock the following: -

- (a) all points within the route,

Employer's Requirements

- (b) with points providing flank protection to the route and the overlap, and
 - (c) With trailing points within the overlap.
- 8.4** Facing points within the overlap shall be set and locked and automatic overlap swinging shall not be employed.
- 8.5** The overlap in respect of which trailing/facing and flank protection points are interlocked shall be established by the position in which the facing points lie at time of setting the route. Counter conditional locking to prevent loss of conditions in the chosen overlap shall apply.
- 8.6** Facing points in the overlap shall be detected NORMAL/REVERSE as required for setting the route and clearing of relevant signal.
- 8.7** In case the points do not fall in the route, but are required to be locked 'Normal' for safety of train operation, such interlocking must be provided.
- 8.8** All main signals shall check track circuits up to the overlap clearance point, including track circuits providing flank protection to the route or overlap.
- 8.9** Overlap track circuit controls for 'Following train' shall be a minimum length of 180m or Snag Dead End in station areas.
- 8.10** The Approach locking of controlled signals shall extend to the sighting point of the Outer signal directly in rear. The sighting point shall be defined as a minimum distance of 1200m on the approach to that signal.
- 8.11** The Approach locking shall be released by the track circuits ahead of the signal and shall require 1st T.C. occupied, then clear with 2nd T.C. occupied; or shall be released by time delay adjustable to between 60 and 120 seconds if the train has not passed the signal.
- 8.12** All main controlled signals shall have signal replacement operated by the track circuit immediately ahead of the signal and shall prove the replacement controls normal after the passage of each train.
- 8.13** All shunt signals within main signal route shall be set automatically with the main route.
When pre-set, the shunt signal route shall be back locked by the main route and shall be approach locked. Release of this approach locking shall only be affected by the train passing the ground shunt signal, or by the "Emergency Route" release.
- 8.15** All signal routes shall release automatically after passage of the train.
- 8.16** Route locking shall be provided to hold points and conflicting routes ahead of the train including overlap locking.
- 8.17** In big yards sectional route release shall be provided.
- 8.18** It shall not be possible to operate a point in case the relevant point track circuit is occupied.
- 8.19** System design shall ensure that route(s) set but not yet occupied shall not be unlocked or be cancelled as a result of power failure or power interruption and also that no route that is set and is being traversed by a train shall become unlocked as a result of a power failure or resumption of supply after a power failure.

Employer's Requirements

- 8.20 The incoming external circuits shall be double cut and shall be fed from independent power supplies.
- 8.21 All interlocking and control circuits shall be in accordance with accepted railway signaling safety principles.

X. BLOCK SYSTEM

1. General

- 1.1 Axle counter block shall be provided for operating trains between adjacent stations under obsolete block system and shall be controlled through the station CBIs. The adjacent stations to the last CBI station of a section shall also be provided with Axle counter block.
- 1.2 This equipment shall be connected at the both ends of the block section through, radio circuits and Fiber optic cable.
- 1.3 The Axle counting system shall operate on the principal with a 2-out-of-2 computer configuration.
- 1.4 The last stop signal of dispatching station shall not be taken OFF without mutual consent of the Station Master of adjacent stations and 'Zero count' of the Axle counters.
- 1.5 The wheel sensor in the field shall be provided at 20 meters ahead of Advance starter signal and 10 meter ahead of Home signal for both Up and Dn directions. The wheel sensors shall be securely fitted in such a way that it will not be possible for the unauthorized person to dismantle it.
- 1.6 All the equipment except the wheel sensors, shall be installed in the equipment room.
- 1.7 Proper lightning and surge protection shall be provided.
- 1.8 The system shall be of proven design and shall have high reliability and long life.
- 1.9 Block Back and Block Forward facility shall be provided and the events shall be recorded.

2. AXLE COUNTER SYSTEM

- 2.1 The Axle counter system shall ensure complete arrival of train and shall prove the clearance/occupation of block section (Advance starter signal of dispatching station to Home signal of receiving station).
- 2.2 The axle counting system should be fit to work on Radio or communication cables.
- 2.3 It should be suitable for 25 KV, 50 Hz electrified section.
- 2.4 Any failure of the equipment shall be on safe side and generate alarm automatically.

Employer's Requirements

- 2.5 The equipment should be fit for speeds up to 160 Km / Hour.
- 2.6 It should be fit for use on 100 Lbs BS Rails or heavier.
- 2.7 Temperature Outdoor equipment -25 ° C to + 70 ° C
 Indoor equipment -5 ° C to + 55 ° C
- 2.8 The minimum transmission distance should be up to 20 KM.
- 2.9 Axle counting indications for both Up and Dn directions shall be provided on the Monitor and control panel
- 2.10 In case of any trouble or malfunction, the equipment should display 'Block occupied' condition and alarm.
- 2.11 The equipment should supply reliable section clearance and occupation information and completely satisfy the safety and reliability required for railway system.
- 2.12 The axle-counter System shall be of such a design that the wheels of Maintenance trolleys passing over the wheel sensor shall not be counted.
- 2.13 The wheel sensor shall be installed ahead of Advance Starter and Home Signals in the Yard and axle-counting console shall be integrated in the Station Master's Control console.
- 2.14 If a train enters or overshoots into a clear block section disregarding the advance starter signal, a 'Local disturbance' indication shall appear at both stations together with continuous sounding of buzzer. However, the axle counter shall display the number of Axles which have entered in block section and if train clears the section, the counting shall decrement and display zero count. The indication shall appear at both stations and buzzer shall stop. This event shall be recorded in the counter and Station Master shall re-set the system by pressing the relevant buttons.
- 2.15 If train overshoots into an occupied block section, the Axle Counter shall indicate the number of Axles which have entered into the block section. In case the train clears the block section (comes back or received at other end) the counting shall decrement and display zero count.
- 2.16 Events data logging shall be provided for at-least 15 days for subsequent checking of the working of Axle counting system. The system must be able to generate diagnostic information for the maintenance staff.
- 2.17 Each Axle Counting System shall be connected to a similar system at the other end of the block section for working of Up and Down trains in the block sections. The indications / status of the Axle Counting System shall be displayed on the Control console in the Station Master's Office. The system should continuously monitor the block section even when there is no train in the section.
- 2.18 On complete arrival of a train at the station, the counting shall decrement in real time and zero count indication shall display in the Counters. In case of miscounting by the axle counter, the 'occupied' indication shall continue on both the consoles. The reset/normalization of Axle counting

Employer's Requirements

system shall be effective through the joint operation of both the Station Masters. The reset buttons shall normally be kept sealed. A counter shall record each operation of this button.

Y. TELEPHONIC COMMUNICATION

- 1.1 Junction station shall be equipped with PMBX or equivalent telephone Exchange of minimum 30 lines for providing telephone link at different train operation duty points.
- 1.2 At wayside station, telephones shall be provided to make telephone link of Station Master with Gateman, Points man and M.L. Points etc. For this purpose small exchange of minimum 10 lines may be provided.
- 1.3 The exchanges along with telephone instruments, cables and the wiring shall be provided as per requirements of the station. The provisional details of such points have been shown on the IYDs.
- 1.4 A pair of telephone cable shall be terminated at all Starter, Home, Advance Starter and Outer signals and location cases for the facility of signal maintenance staff to talk with Train Dispatcher/Station Master. 3 portable Telephone sets for maintenance staff shall be provided at each way side station and 6 at Junction station.
- 1.5 Independent telephones with signaling and ringing arrangement shall be provided at all Outer signals to talk with the Station Master. These telephones shall be in a locked and sealed box fitted on the signal posts. Bidders shall provide a secure hands-free phone and may be actuated by the authorized persons only. It should not be affected by dust and vibrations. The details shall be submitted for the approval of the Employer.
- 1.7 Independent Block Telephones shall be provided at each station to talk with adjacent station and in case of defect in this telephone an independent alternate Block Telephones shall be provided on a separate pair of Telecom: cable for use in emergency. These telephones shall have built in calling facility. The bidders may provide Copper or Fiber Optic cable between stations.
- 1.8 The Communications equipment and system shall be fed from a separate dedicated supply consisting of battery and automatic charger of suitable voltage rating and capacity for the equipment operating voltages and load.

Z. PROVISION OF OPERATING SYSTEM AND SOFTWARE FOR AIR-GAPPED CBI SYSTEM

1. Introduction

- 1.1 CBI System”:
Refers to the complete Computer-Based Interlocking hardware and software system, classified as a Critical Isolated System, with no physical or wireless connection to any public network or the internet, ensuring full operational security and integrity.
- 1.2 “Operating System (OS)”:
Denotes the specified Microsoft Windows Operating System, which shall be a Long-Term Servicing Channel (LTSC) version to ensure stability, extended support, and cybersecurity compliance for safety-critical railway applications.
- 1.3 “Application Software”:
Refers to the proprietary software developed by the Contractor to execute CBI functionality on the designated hardware platform. The application shall be fully integrated, tested, and certified for use within the CBI environment in accordance with relevant railway signaling standards.

2. Mandatory Provision of Operating System

The Contractor shall supply a fully licensed, genuine copy of the Microsoft Windows Long-Term Servicing Channel (LTSC) Operating System for every server, workstation, and critical hardware component within the CBI system. The specific version shall be the latest stable LTSC release available at the time of system commissioning, unless otherwise approved in writing due to verified compatibility requirements.

3. License Terms for Air-Gapped Systems

All provided Operating System licenses shall comply with the following non-negotiable conditions:

3.1 Perpetual, Stand-Alone Licenses

Licenses shall be perpetual and valid for indefinite use of the specified OS version. The model must be suitable for a permanently air-gapped environment, requiring no online validation or reactivation.

3.2 Full Ownership and Transfer

Employer's Requirements

All license rights, including media, documentation, and Certificates of Authenticity (COA), shall be formally assigned and delivered to Pakistan Railways upon final system acceptance. Pakistan Railways shall be the sole owner of record for all licenses.

3.3 Pre-Validated and Activated Media

The OS shall be pre-installed, configured, and pre-activated on all supplied systems. The Contractor shall provide a verified method for offline re-activation in case of hardware replacement or system restoration. Any digital rights management (DRM) mechanism requiring internet access is strictly prohibited.

3.4 LTSC Support Cycle

The Contractor shall provide a written guarantee from Microsoft or its authorized distributor confirming that the selected LTSC version will receive security updates throughout its full support lifecycle (minimum 10 years). The Contractor shall remain responsible for the timely provision and delivery of these updates.

4. Application Software

4.1 Perpetual Right to Use

Pakistan Railways shall hold a perpetual, irrevocable, royalty-free right to use, maintain, and execute the Application Software on all supplied CBI hardware. The software shall remain compatible, secure, and fully functional throughout the system's operational life.

5. Long-Term Support and Update Protocol for Isolated Systems

Given the air-gapped design of the CBI system, the Contractor's support obligations shall include:

5.1 Offline Update Delivery

The Contractor shall establish a secure, documented, and tested process for delivering all OS and Application Software updates offline:

- **Vetting and Testing:** All Microsoft patches and internal updates shall be **obtained, tested, and certified** in the Contractor's lab for full CBI compatibility.
- **Secure Transfer:** Updates shall be delivered to Pakistan Railways on **read-only, cryptographically verified media** (e.g., write-protected USB drives).
- **Application Procedures:** Detailed, **step-by-step update procedures** shall be provided for safe application in the live environment.

Employer's Requirements

5.2 Future OS Migration

For a minimum of 25 years from system acceptance, the Contractor shall ensure a migration path to newer supported OS versions when the current LTSC release nears end-of-life.

This service shall include porting, testing, and re-certification of the Application Software with no loss of functionality, at a pre-negotiated and reasonable cost.

5.3 System Imaging and Recovery

The Contractor shall provide complete, bootable system images for each master server and workstation, along with tools and documented procedures for full system restoration within the air-gapped environment.

6. Delivery and Documentation for Isolated Systems

1. At the time of final handover, the Contractor shall deliver to Pakistan Railways:
2. Original or certified copies of the **Windows LTSC installation media**.
3. All **license keys, activation codes, and offline activation tools**.
4. A **certified and tested library** of all security patches released up to the handover date.
5. **Comprehensive system documentation**, including detailed **offline update procedures, recovery steps, and configuration records**.

AA. Equipment End of Life, Shelf Life, and Warranty

1. End of Life (EoL) Declaration

The Contractor shall provide a written End of Life declaration from each original manufacturer for all major hardware and software components supplied under this contract. This declaration shall specify the expected production availability, support duration, and last date for spare part supply. No component declared as “End of Life” or scheduled for discontinuation within ten (10) years from the date of commissioning shall be offered.

2. Shelf Life

All equipment, sub-assemblies, and spare parts shall be brand new, unused, and within their valid shelf life at the time of delivery. The remaining shelf life shall be no less than 80% of the manufacturer's rated storage duration. Proper packaging, labeling, and storage instructions shall be provided to maintain equipment integrity until installation.

3. Warranty Period

The Contractor shall provide a minimum two (2)-year comprehensive warranty from the date of system commissioning, covering all hardware, software, and field devices. During the warranty period, any failure, degradation, or defect shall be rectified or replaced at no cost to Pakistan Railways. The warranty shall include parts, labor, transportation, and associated software updates, ensuring uninterrupted system availability.

4. Post-Warranty Support

Prior to warranty expiry, the Contractor shall propose an extended maintenance and support plan in line with the Supervision of Maintenance Contract (SOM), ensuring continuity of service and timely replacement of any components approaching end-of-life.

AB. Guidelines for Supervision of Maintenance (SOM)

1. Scope of Work

The Contractor shall provide *Supervision of Maintenance (SOM)* services for the **Computer-Based Interlocking (CBI) System and Associated Equipment** installed under the project, for a period of **two (02) years** from the date of successful installation and handing over to Pakistan Railways.

The scope includes:

- Technical supervision and guidance to Pakistan Railways maintenance staff.
- Regular inspection, testing, and preventive maintenance support.
- Fault diagnosis and rectification support.
- Software and configuration health checks.

Employer's Requirements

- Remote and on-site support as required.
- Submission of quarterly performance and maintenance reports.

2. Duration

- The SOM period shall commence immediately after the official handing over and acceptance of the installed system/equipment by Pakistan Railways.
- The duration shall be **twenty-four (24) calendar months** from the commencement date.

3. Contractor's Obligations

- The Contractor shall ensure availability of qualified engineers/technicians during the SOM period.
- The Contractor shall provide all necessary technical support, tools, and documentation as required for maintenance supervision.
- Any defect observed during the SOM period shall be rectified by the Contractor at no additional cost.
- The Contractor shall train designated Pakistan Railways staff during the SOM period as part of capacity building.

4. Payment Terms

- **No interim or advance payments** shall be made during the SOM period.
- **Full and final payment** shall be made **after successful completion of the two-year SOM period**, subject to:
 - Satisfactory performance certification issued by the Pakistan Railways representative/Engineer-in-Charge.
 - Submission and acceptance of all required documentation, reports, and completion certificates.

6. Termination and Penalties

- If the Contractor fails to provide the required supervision or neglects maintenance responsibilities, Pakistan Railways may terminate the contract and forfeit the performance security.

7. Ownership and Responsibility

- All installed equipment and systems shall remain the property of Pakistan Railways.
- The Contractor shall not remove, alter, or replace any equipment without prior written consent.

Employer's Requirements

- The Contractor is responsible for any damage caused due to negligence or faulty supervision during the SOM period.

8. Completion and Final Acceptance

- Upon completion of the SOM period, a **Joint Inspection** shall be carried out by Pakistan Railways and the Contractor.
- If found satisfactory, a **Completion Certificate** shall be issued, authorizing the release of the final payment and performance guarantee.

AC. P-WAY MATERIAL

List of P-way material as below:

SN	Items	Unit	Qty
1.	Crossing Timber 13' x10"x6"	Each	40
2.	Crossing Wooden Sleeper 9'x10"x6"	Each	108
3.	Crossing Wooden Sleeper 14'x10"x6"	Each	03
4.	Crossing Wooden Sleeper 15'x10"x6"	Each	03
5.	Gauge Tie Plate (100-RE) for Switch Insulated	Each	18
6.	Fish Plate (90-R) SS	Each	04
7.	W-I Dog Spike	Each	360
8.	Round Spike BG	Each	575
9.	Tongue Rail 15'-6" RH	Each	03
10.	Tongue Rail 15'-6" LH	Each	03
11.	Tongue Rail 21'-25" (90 RH)	Each	02
12.	Tongue Rail 21'-25" (90 LH)	Each	02
13.	Slide Chair UIC-54	Each	02
14.	Bolts for Stretcher Bar	Each	10
15.	W-9 Slide Chair (100-RE)	Each	02
16.	Gauge Tie Plate (90-R) for Switch Insulated	Each	14
17.	Gauge Tie Plate 54-UIC	Each	02
18.	Slide Chair (90-R) (Lead Bearing Plate)	Each	54
19.	Half & Full Head Bolt & Nut	Each	35
20.	Full Bolt & Nut — Each	Each	50
21.	Bolts & Nuts 10" × 1"	Each	02
22.	Heel Block (3405)	Each	02
23.	Heel Block (3406)	Set	02
24.	Leading & Following Stretcher Bar (90R)	Each	04
25.	Spring Washer 1" Dia	Each	46
26.	Square Washer 2"-1/2 × 1/2	Each	28
27.	Screw spillies for UIC-54	Each	254

The items specified in the table include tentative minimum quantities and items. Bidder shall be required to ensure all items and quantities pertaining to the complete solution which shall include all ancillary, incidental, and prerequisite tasks necessary for its complete and satisfactory execution as per the terms of the bidding documents and the invoked railway policy