BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: 203

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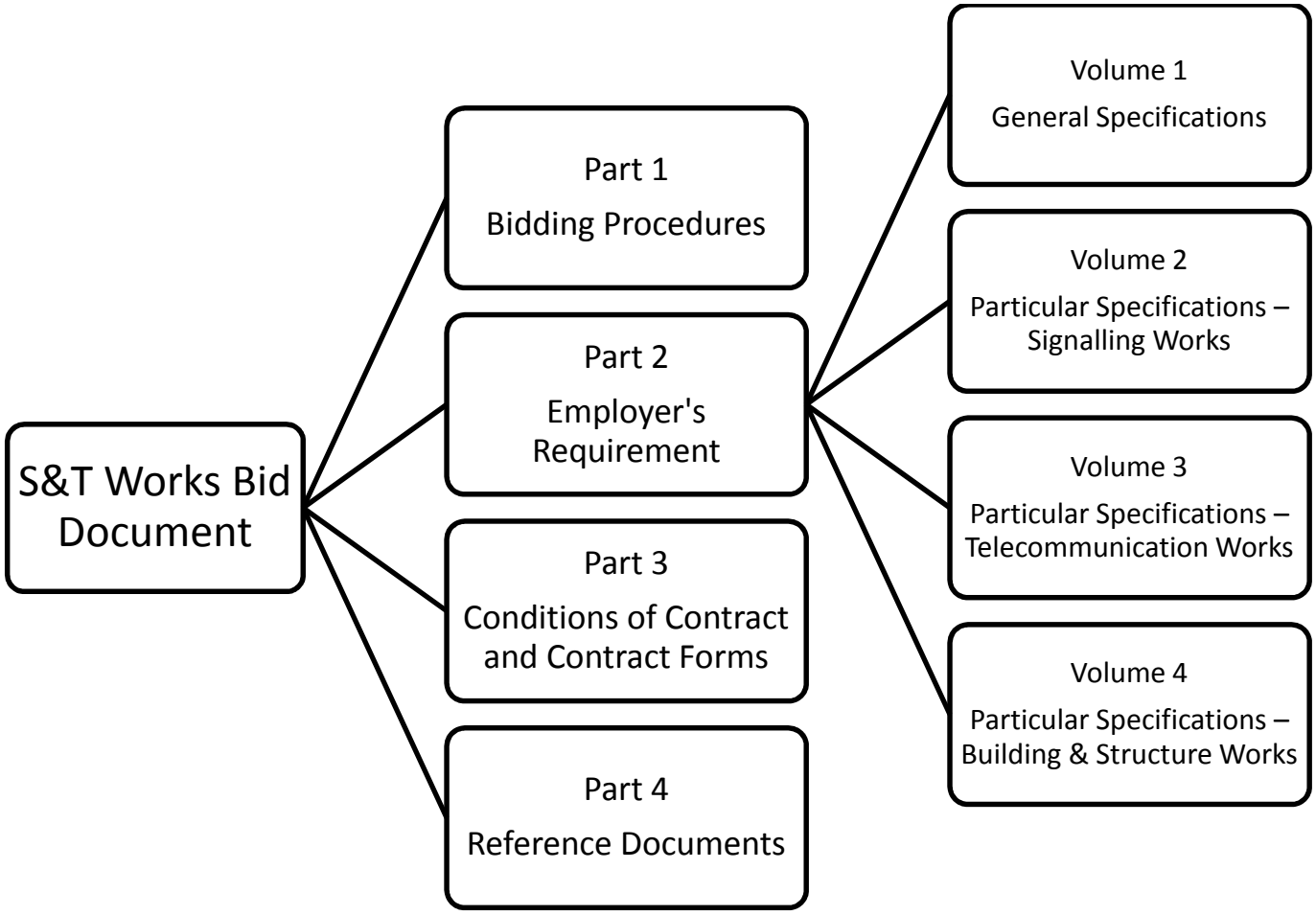
ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

Part 1, Bidding Procedures

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD (A GOVERNMENT OF INDIA ENTERPRISE)

COUNTRY: **INDIA**

30.03.2015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PART 1

Bidding Procedures

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Section I. Instructions to Bidders

A. General

1. Scope of Bid

1.1 In connection with the Invitation for Bids indicated in the Bid Data Sheet (BDS), the Employer, as indicated in the BDS, issues this Bidding Document for the procurement of Works as specified in Section VI, Employer*'s* Requirements. The name, identification, and number of lots (contracts) of the International Competitive Bidding (ICB) are **provided in the BDS.**

1.2 Unless otherwise stated, throughout this Bidding Document definitions and interpretations shall be as prescribed in the General Conditions, Section VII.

2. Source of Funds

2.1 The Borrower or Recipient (hereinafter called "Borrower") **indicated in the BDS** has applied for or received financing (hereinafter called "funds") from the International Bank for Reconstruction and Development (hereinafter called "the Bank") toward the cost of the project **named in the BDS.** The Borrower intends to apply a portion of the funds to eligible payments under the contract*(s)* for which this Bidding Document is issued.

2.2 Payments by the Bank will be made only at the request of the Borrower and upon approval by the Bank in accordance with the terms and conditions of the financing agreement between the Borrower and the Bank (hereinafter called the Loan Agreement), and will be subject in all respects to the terms and conditions of that Loan Agreement. No party other than the Borrower shall derive any rights from the Loan Agreement or have any claim to the funds.

2.3 The Loan Agreement prohibits a withdrawal from the loan account for the purpose of any payment to persons or entities, or for any import of equipment, plant, or materials, if such payment or import is prohibited by a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations.

3. Corrupt Practices

3.1 The Bank requires that Borrowers (including beneficiaries of Bank loans), as well as Bidders, Suppliers, Contractors and their agents (whether declared or not), personnel, subcontractors, sub-consultants, service providers and suppliers, under Bank-financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuit of this policy, the Bank:

(a) defines, for the purposes of this provision, the terms set forth below as follows:

(i) "corrupt practice" is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party[1];

(ii) "fraudulent practice" is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation[2];

(iii) "collusive practice" is an arrangement between two or more parties[3] designed to achieve an improper purpose, including to influence improperly the actions of another party;

(iv) "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party[4] or the property of the party to influence improperly the actions of a party;

(v) "obstructive practice" is

(aa) deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or

(bb) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under sub-clause 3.2 below.

[1] "another party" refers to a public official acting in relation to the procurement process or contract execution]. In this context, "public official" includes World Bank staff and employees of other organizations taking or reviewing procurement decisions.

[2] "Party" refers to a public official; the terms "benefit" and "obligation" relate to the procurement process or contract execution; and the "act or omission" is intended to influence the procurement process or contract execution.

[3] "Parties" refers to participants in the procurement process (including public officials) attempting to establish bid prices at artificial, non competitive levels.

[4] "Party" refers to a participant in the procurement process or contract execution.

(b) will reject a proposal for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for the contract in question;

(c) will cancel the portion of the loan allocated to a contract if it determines at any time that representatives of the Borrower or of a beneficiary of the loan engaged in corrupt, fraudulent, collusive, or coercive practices during the procurement or the execution of that contract, without the Borrower having taken timely and appropriate action satisfactory to the Bank to remedy the situation; and

(d) will sanction a firm or an individual, at any time, in accordance with prevailing Bank's sanctions procedures[a], including by publicly declaring such firm or individual ineligible, either indefinitely or for a stated period of time: (i) to be awarded a Bank-financed contract; and (ii) to be a nominated[b] sub-contractor, consultant, manufacturer or supplier, or service provider of an otherwise eligible firm being awarded a Bank-financed contract.

3.2 In further pursuance of this policy, Bidders shall permit the Bank to inspect any accounts and records and other documents relating to the Bid submission and contract performance, and to have them audited by auditors appointed by the Bank. Furthermore, Bidders shall be aware of the provision stated in the General Conditions (GC) - 15.2).

4. Eligible Bidders

4.1 A Bidder may be a private entity or a government-owned entity—subject to ITB 4.5—or any combination of such entities in the form of a joint venture, or association (JVA) under an existing agreement or with the intent to enter into such an agreement supported by a letter of intent. In the case of a joint venture, or association:

(a) **unless otherwise specified in the BDS,** all partners

[a] A firm or an individual may be declared ineligible to be awarded a Bank-financed contract upon completion of the Bank's sanctions proceedings as per its sanctions procedures, including inter alia: (i) temporary suspension in connection with an ongoing sanctions proceeding; (ii) cross-debarment as agreed with other International Financial Institutions, including Multilateral Development Banks; and (iii) the World Bank Group corporate administrative procurement sanctions procedures for fraud and corruption.

[b] A nominated sub-contractor, consultant, manufacturer or supplier, or service provider (different names are used depending on the particular bidding document) is one which either has been: (i) included by the bidder in its pre-qualification application or bid because it brings specific and critical experience and know-how that are accounted for in the evaluation of the bidder's pre-qualification application or the bid; or (ii) appointed by the Borrower.

shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms, and

(b) the JVA shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the partners of the JVA during the bidding process and, in the event the JVA is awarded the Contract, during contract execution.

4.2 A Bidder, and all partners constituting the Bidder, shall have a nationality of an eligible country, as defined in *Guidelines: Procurement under IBRD Loans and IDA Credits,* January 2011, (hereinafter referred to as the Guidelines), in accordance with Section V, Eligible Countries. A Bidder shall be deemed to have the nationality of a country if the Bidder is a national or is constituted, incorporated, or registered and operates in conformity with the provisions of the laws of that country. This criterion shall also apply to the determination of the nationality of proposed subcontractors or suppliers for any part of the Contract including related services.

4.3 A Bidder shall not have a conflict of interest. All Bidders found to have a conflict of interest shall be disqualified. A Bidder may be considered to have a conflict of interest with one or more parties in this bidding process, if :

(a) they have a controlling partner in common; or

(b) they receive or have received any direct or indirect subsidy from any of them; or

(c) they have the same legal representative for purposes of this bid; or

(d) they have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or

(e) a Bidder submits more than one bid in this bidding process, either individually or as a partner in a joint venture, except for alternative offers permitted under ITB Clause 13. This will result in the disqualification of all such bids. However, this does not limit the participation of a Bidder as a subcontractor in another bid or of a firm as a subcontractor in more than one bid. or

(f) a Bidder or any of its affiliates participated as a

consultant in the preparation of the design or technical specifications of the Works that are the subject of the bid.

(g) A Bidder or any of its affiliates has been hired (or is proposed to be hired) by the Employer or the Borrower as Engineer for the contract.

4.4 A Bidder that has been sanctioned by the Bank in accordance with the above ITB 3.1 (d), or in accordance with the Bank's Guidelines on Preventing and Combating Corruption in Projects Financed by IBRD Loans and IDA Credits and Grants, shall be ineligible to be awarded a Bank-financed contract, or benefit from a Bank-financed contract, financially or otherwise, during such period of time as the Bank shall determine.

4.5 Government-owned entities in the Borrower's country shall be eligible only if they can establish that they (i) are legally and financially autonomous, (ii) operate under the principles of commercial law, and (iii) are not dependent agencies of the Employer or the Borrower.

4.6 Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer, as the Employer shall reasonably request.

4.7 In case a prequalification process has been conducted prior to the bidding process, this bidding is open only to prequalified Bidders.

4.8 Firms shall be excluded if:

(a) as a matter of law or official regulation, the Borrower's country prohibits commercial relations with that country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of goods or related services required; or

(b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's country prohibits any import of goods or contracting of works or services from that country or any payments to persons or entities in that country.

5. Eligible Materials, Equipment and Services

5.1 The materials, equipment and services to be supplied under the Contract shall have their origin in eligible source countries as defined in ITB 4.2 above and all expenditures under the Contract will be limited to such materials,

equipment and services.

5.2 For purposes of ITB 5.1 above, "origin" means the place where the materials and equipment, or component parts thereof are mined, grown, produced or manufactured, and from which the services are provided. The materials and equipment components are produced when, through manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that is substantially in its basic characteristics or in purpose or utility from its components.

B. Contents of Bidding Document

6. Sections of Bidding Document

6.1 The Bidding Document consists of Parts 1, 2, 3 and 4, which include all the Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8.

PART 1 Bidding Procedures

- Section I. Instructions to Bidders (ITB)
- Section II. Bid Data Sheet (BDS)
- Section III. Evaluation and Qualification Criteria
- Section IV. Bidding Forms
- Section V. Eligible Countries

PART 2 Employer's Requirements

- Section VI. Employer's Requirements

PART 3 Conditions of Contract and Contract Forms

- Section VII. General Conditions (GC*)*
- Section VIII. Particular Conditions (PC)
- Appendix to Tender
- Section IX. Contract Forms

PART 4 Reference Documents

6.2 The Invitation for Bids issued by the Employer is not part of the Bidding Document.

6.3 The Employer is not responsible for the completeness of the Bidding Document and its addenda, if they were not obtained directly from the source stated by the Employer in the Invitation for Bids.

6.4 The Bidder is expected to examine all instructions, forms, terms, and specifications in the Bidding Document. Failure to furnish all information or documentation required by the

Bidding Document may result in the rejection of the bid.

7. Clarification of Bidding Document, Site Visit, Pre-Bid Meeting

7.1 A prospective Bidder requiring any clarification of the Bidding Document shall contact the Employer in writing at the Employer's address **indicated in the BDS** or raise his enquiries during the pre-bid meeting if provided for in accordance with ITB 7.4. The Employer will respond to any request for clarification, provided that such request is received no later than twenty-eight (28) days prior to the deadline for submission of bids. The Employer's response shall be in writing with copies to all Bidders who have acquired the Bidding Document in accordance with ITB 6.3, including a description of the inquiry but without identifying its source. Should the Employer deem it necessary to amend the Bidding Document as a result of a request for clarification, it shall do so following the procedure under ITB 8, ITB 19.2 and ITB 35.2.

In addition a prospective Bidder pointing out any error/ discrepancy in Employer's Requirement shall contact the Employer in writing at the Employer's address indicated in the BDS. The Employer will respond to any such suggestion, provided that such request is received no later than twenty-eight (28) days prior to the deadline for submission of bids. The Employer's response shall be in writing with copies to all Bidders who have acquired the Bidding Document in accordance with ITB 6.3, including a description of the error/ discrepancy and accepted suggestion by the Employer but without identifying its source.

7.2 The Bidder is advised to visit and examine the site of Works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for the design and construction of Works. The costs of visiting the site shall be at the Bidder's own expense.

7.3 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the Bidder, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

7.4 The Bidder's designated representative is invited to attend a pre-bid meeting, if **provided for in the BDS.** The

purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

7.5 The Bidder is requested, as far as possible, to submit any questions in writing, to reach the Employer not later than one week before the meeting.

7.6 Minutes of the pre-bid meeting, including the text of the questions raised, without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Bidders who have acquired the Bidding Document in accordance with ITB 6.3. Any modification to the Bidding Documents that may become necessary as a result of the pre-bid meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to ITB 8 and not through the minutes of the pre-bid meeting.

7.7 Nonattendance at the pre-bid meeting will not be a cause for disqualification of a Bidder.

8. Amendment of Bidding Document

8.1 At any time prior to the deadline for submission of bids, the Employer may amend the Bidding Document by issuing addenda.

8.2 Any addendum issued shall be part of the Bidding Document and shall be communicated in writing to all who have obtained the Bidding Document from the Employer in accordance with ITB 6.3.

8.3 To give prospective Bidders reasonable time in which to take an addendum into account in preparing their bids, the Employer may, at its discretion, extend the deadline for the submission of bids, pursuant to ITB 19.2 and/or ITB 35.2

9. Cost of Bidding

9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall not be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

10. Language of Bid

10.1 The Bid, as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Employer, shall be written in the language **specified in the BDS.** Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified in the BDS, in which case, for purposes of interpretation of the Bid, such translation shall govern.

C1. First Stage Technical Proposals: Preparation

11. Documents Comprising the First Stage Technical Proposal

11.1 The first stage technical proposal submitted by the Bidder shall comprise the following:

(a) Letter of First Stage Bid;

(b) alternative technical proposals in accordance with ITB 13;

(c) written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 17.2;

(d) documentary evidence established in accordance with ITB 14 that the materials, equipment and services offered by the Bidder in its bid or in any alternative bid are eligible;

(e) documentary evidence in accordance with ITB 15 establishing the Bidder's eligibility and qualifications to perform the contract if its Bid is accepted;

(f) documentary evidence established in accordance with ITB 16 that the materials, equipment and services offered by the Bidder conform to the Bidding Document;

(g) in the case of a technical proposal submitted by a JVA, JVA agreement, or letter of intent to enter into a JVA including a draft agreement, indicating at least the parts of the Works to be executed by the respective partners;

(h) list of subcontractors, in accordance with ITB 16.3; and

(i) any other document **required in the BDS.**

First stage technical proposals are unpriced proposals and shall contain no prices or price schedules or other reference to rates and prices for completing the facilities. First stage technical proposals containing such price information will be rejected.

12. Letter of First Stage Bid and Attachments

12.1 The Letter of First Stage Bid and any attachments shall be prepared using the relevant forms furnished in Section IV, Bidding Forms. The forms must be completed as instructed in each form.

13. Alternative Technical

13.1 Bidders shall note that they are permitted to propose technical alternatives with their first stage technical

Proposals

proposals in addition to or in lieu of the requirements specified in the bidding documents, provided they can document that the proposed technical alternatives are to the benefit of the Employer, that they fulfill the principal objectives of the contract, and that they meet the basic performance and technical criteria specified in the bidding documents.

13.2 Any alternative technical proposal submitted by bidders as part of their first stage technical proposal will be the subject of clarification with the Bidder, pursuant to ITB 25.

14. Documents Establishing the Eligibility of Materials , Equipment and Services

14.1 To establish the eligibility of the materials, equipment and services in accordance with ITB Clause 5, Bidders shall provide documentary evidence consisting of a statement on the country of origin of the materials, equipment and services offered.

15. Documents Establishing the Eligibility and Qualifications of the Bidder

15.1 To establish its eligibility and qualifications to perform the Contract in accordance with Section III, Evaluation and Qualification Criteria, the Bidder shall provide the information requested in the corresponding information sheets included in Section IV, Bidding Forms.

15.2 Domestic Bidders, individually or in joint ventures, applying for eligibility for domestic preference shall supply all information required to satisfy the criteria for eligibility as described in ITB 46.

16. Documents Establishing Conformity of the Materials , Equipment and Services

16.1 The Bidder shall furnish a Technical Proposal including a statement of work, methods, equipments, personnel, schedule and any other information as stipulated in Section IV, in sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion time.

16.2 The documentary evidence of the conformity of the material, equipment and services with the bidding documents may be in the form of literature, drawings and data, and shall include:

a) Adequate evidence demonstrating the substantial responsiveness of the material, equipment and services to those specifications. Bidders shall note that standards for workmanship, materials and equipment designated by the Employer in the Bidding Document are intended to be descriptive (establishing standards of quality and performance) only and not restrictive. The Bidder may substitute alternative standards, brand names and/or catalog numbers in its technical proposal,

provided that it demonstrates to the Employer's satisfaction that the substitutions are substantially equivalent or superior to the standards designated in the Specification.

16.3 For major items of supply or services as listed by the Employer in Section III, Evaluation and Qualification Criteria, which the Bidder intends to purchase or subcontract, the Bidder shall give details of the name and nationality of the proposed Subcontractors, including manufacturers, for each of those items. In addition, the Bidder shall include in its technical proposal information establishing compliance with the requirements specified by the Employer for these items.

16.4 The Bidder shall be responsible for ensuring that any Subcontractor proposed complies with the requirements of ITB 4, and that any materials, equipment or services to be provided by the Subcontractor comply with the requirements of ITB 5 and 15.1.

17. Format and Signing of First Stage Technical Proposal

17.1 The Bidder shall prepare one original of the documents comprising the bid as described in ITB 11 and clearly mark it "FIRST STAGE TECHNICAL PROPOSAL - ORIGINAL." Alternative bids, if permitted in accordance with ITB 13, shall be clearly marked "FIRST STAGE TECHNICAL PROPOSAL - ALTERNATIVE". In addition, the Bidder shall submit copies of the bid, in the number **specified in the BDS** and clearly mark them "FIRST STAGE TECHNICAL PROPOSAL - COPY" and, "FIRST STAGE TECHNICAL PROPOSAL – ALTERNATIVE - COPY" In the event of any discrepancy between the original and the copies, the original shall prevail.

17.2 The original and all copies of the first stage technical proposal shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as **specified in the BDS** and shall be attached to the first stage technical proposal. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the first stage technical proposal where entries or amendments have been made shall be signed or initialed by the person signing the bid.

17.3 A bid submitted by a JVA shall be signed so as to be legally binding on all partners.

17.4 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the bid.

C2. First Stage Technical Proposals: Submission and Opening

18. Submission, Sealing and Marking of First Stage Technical Proposals

18.1 Bidders may always submit their first stage technical proposals by mail or by hand. When so **specified in the BDS**, bidders shall have the option of submitting their first stage technical proposals electronically.

(a) Bidders submitting first stage technical proposals by mail or by hand, shall enclose the original and each copy of the technical proposal, including alternative technical proposals, if permitted in accordance with ITB 13, in separate sealed envelopes, duly marking the envelopes as "FIRST STAGE TECHNICAL PROPOSAL - ORIGINAL", "FIRST STAGE TECHNICAL PROPOSAL - ALTERNATIVE" and "FIRST STAGE TECHNICAL PROPOSAL - COPY" and, "FIRST STAGE TECHNICAL PROPOSAL – ALTERNATIVE - COPY" These envelopes containing the original and the copies shall then be enclosed in one single envelope. The rest of the procedure shall be in accordance with ITB 21.2 and 21.3.

(b) Bidders submitting first stage technical proposals electronically shall follow the electronic submission procedures **specified in the BDS.**

18.2 The inner and outer envelopes shall:

(a) bear the name and address of the Bidder;

(b) be addressed to the Employer in accordance with ITB 19.1;

(c) bear the specific identification of this bidding process indicated in accordance with ITB 1.1; and

(d) bear a warning not to open before the time and date for bid opening.

18.3 If all envelopes are not sealed and marked as required, the Employer will assume no responsibility for the misplacement or premature opening of the technical proposal.

19. Deadline for Submission of First Stage Technical Proposals

19.1 First stage technical proposals must be received by the Employer at the address and no later than the date and time **indicated in the BDS.** Any first stage technical proposal received by the Employer after the deadline for submission of bids shall be declared late, rejected, and returned unopened to the Bidder.

19.2 The Employer may, at its discretion, extend the deadline for the submission of first stage technical proposals by amending the Bidding Document in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.

20. Substitution and Modification of First Stage Technical Proposals

20.1 In case a Bidder wishes to substitute or modify its first stage technical proposal after it has been submitted and prior to the deadline for first stage technical proposal submission, it may do so by sending a written notice, as per ITB 19.1 and its substituted or modified first stage technical proposal will be opened as per ITB 21.

21. Opening of First Stage Technical Proposals by Employer

21.1 The Employer shall conduct the bid opening of the first stage technical proposals in public, in the presence of Bidders` designated representatives and anyone who choose to attend, and at the address, date and time s**pecified in the BDS.** Any specific procedures required if electronic bidding is permitted in accordance with ITB 18.1 shall be as **specified in the BDS.**

21.2 The names of all bidders who submitted first stage technical proposals will be read out, and other such details as the Employer, at its discretion, may consider appropriate, will be announced at the opening.

21.3 The Employer shall prepare a record of the first stage technical proposal opening that shall include, as a minimum: the name of the Bidder, including any alternative bids. The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Bidders who submitted technical proposals in time, and posted online when electronic bidding is permitted.

C3. First Stage Technical Proposals: Evaluation

22. Determination of Responsiveness of First Stage

22.1 The Employer will examine the first stage technical proposals to determine whether they are complete, whether the documents have been properly signed and whether the bids are generally in order. Any bids found to be non

Technical Proposals

responsive or not meeting the minimum levels of the performance or other criteria specified in the bidding document will be rejected by the Employer and not included for further consideration. The Employer will also carry out a preliminary examination of any alternative bids submitted by bidders.

22.2 The Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial omissions in the first stage technical proposal related to documentation requirements. Failure of the Bidder to comply with the request may result in the rejection of its technical proposal.

23. Technical Evaluation of First Stage Technical Proposals

23.1 The Employer will carry out a detailed evaluation of the first stage technical proposals in order to determine whether the technical aspects are in compliance with the Bidding Document. In order to reach such a determination, the Employer will examine and compare the technical proposals on the basis of the information supplied by the bidders, taking into account overall completeness and compliance with the Employer's Requirements and the technical merits of alternatives offered;

(a) overall completeness and compliance with the Employer's Requirements; the technical merits of alternatives offered; conformity of the Works offered with specified performance criteria, including conformity with the specified minimum (or maximum, as the case may be) requirement corresponding to each functional guarantee, as indicated in the Specification and in Section III - Evaluation and Qualification Criteria; suitability of the Works offered in relation to the environmental and climatic conditions prevailing at the site; and quality, function and operation of any process control concept included in the bid;

(b) Compliance with the time schedule called for in the corresponding Appendix to the Contract Agreement and any alternative time schedules offered by bidders, as evidenced by a milestone schedule provided in the technical proposal;

(c) other relevant factors, if any, listed in Section III, Evaluation and Qualification Criteria; and

(d) any deviations to the commercial and contractual provisions stipulated in the bidding documents

23.2 The Employer will also review complete alternative technical

proposals, if any, offered by the Bidder, pursuant to ITB 13, to determine whether such alternatives may constitute an acceptable basis for a Second Stage bid to be submitted on its own merits.

24. Eligibility and Qualification of the Bidder

24.1 The Employer shall determine to its satisfaction whether Bidders determined as having submitted responsive First Stage Technical Proposals are eligible and meet the qualification criteria specified in Section III, Evaluation and Qualification Criteria.

24.2 The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB 15, and on any additional information which the Employer may request from the Bidder to support such evidence.

24.3 An affirmative determination will be a prerequisite for the Employer to invite the Bidder to a clarification meeting in accordance with ITB 25. A negative determination will result in rejection of the Bidder's first stage technical proposal.

24.4 The capabilities of the manufacturers and subcontractors proposed to be used by the Bidders for Employer-identified major items of supply or services will also be evaluated for acceptability in accordance with Section III, Evaluation and Qualification Criteria. Should a manufacturer or subcontractor be determined to be unacceptable, if invited to submit a Second Stage Bid, the Bidder will be required to substitute an acceptable manufacturer or subcontractor.

D. Clarification of First Stage Technical Proposals

25. Clarification Procedures

25.1 The Employer may conduct clarification meetings with each or any Bidder to clarify any aspects of its First Stage technical proposal that require explanation and to review any Bidder's proposed alternative solutions or reservations to the commercial or contractual provisions of the bidding documents. The Employer may also seek clarifications in writing.

25.2 The Employer may bring to the attention of the Bidder any amendments or changes which the Employer may require to be made to the First Stage technical proposal; however the Employer may not require amendments or changes at variance from the Employers' requirements unless the Employer intends to amend the Bidding Document in accordance with ITB 26.1(a).

25.3 The Employer will advise the Bidder of any deviations to the commercial or contractual provisions of the bidding documents in the First Stage technical proposal, that are unacceptable and that are to be withdrawn in the Second Stage bid.

25.4 The Employer will also advise the Bidder whether the proposed alternative technical proposal, if any, is acceptable, and will identify the degree (if any) to which such an alternative bid may be incorporated in the Bidder's Second Stage bid.

25.5 The Employer will issue a Memorandum titled ***"Changes Required Pursuant to First Stage Evaluation,"*** documenting the clarifications made in writing and/or in a meeting, if any, and including an Annex listing all decisions, and required amendments or changes resulting from the clarification of the First Stage technical proposal. The Memorandum will be communicated to the Bidder as part of the invitation to submit the Second Stage bid.

26. Invitation to Submit Second Stage Bids

26.1 At the end of the clarification process pursuant to ITB 25, conducted as necessary:

(a) the Employer may need to issue an amendment to the Bidding Document resulting from the First Stage evaluation and clarification process, with the objective of clarifying the requirements and improving competition without compromising essential project objectives and/or

(b) in regard to all bidders, the Employer will either:

(i) invite the Bidder to submit a final updated technical and a commercial Second Stage bid based on its First Stage technical proposal taking into account the Bidding Document, if and as amended, and any other modifications as recorded in the Annex to the Memorandum entitled "Changes Required Pursuant to First Stage Evaluation". Bidders will be allowed to submit only one Second Stage Bid, or

(ii) notify the Bidder that its bid has been rejected on the grounds of being substantially non-responsive, or that the Bidder does not meet the minimum qualification requirements set forth in the Bidding Document.

26.2 The deadline, for submission of Second Stage bids will be specified in the invitation to submit Second Stage bids,

pursuant to ITB 35.1.

26.3 Bidders are not allowed to form JVA(s) with other bidders, nor change the partner or structure of the JVA if the Bidder in the First Stage was a JVA.

E1. Second Stage Bid Preparation

27. Documents Comprising the Bid

27.1 The Second Stage Bid submitted by the Bidder shall comprise the following:

(a) Letter of Bid

(b) Completed schedules as required, including Price Schedules, in accordance with ITB 28 and 29;

(c) Bid Security, in accordance with ITB 32;

(d) written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 33.2;

(d) the updated first stage technical proposal, comprising any modifications required to the first stage technical proposal as recorded in the Memorandum entitled “Changes Required Pursuant to First Stage Evaluation”;

(f) documentary evidence established in accordance with ITB 14 that any additional or varied materials , equipment and services offered by the Bidder, and not included in the first stage technical proposal, are eligible;

(g) documentary evidence regarding any changes that may have occurred between the time of submitting the First and Second Stage bids that have any material effect on the Bidder’s eligibility and qualifications to perform the Contract.

(h) documentary evidence establishing that any additional or varied facilities to be supplied and installed by the Bidder, in accordance with the requirements of the Memorandum entitled “Changes Required Pursuant to First Stage Evaluation”, are technically acceptable. The documentary evidence of the conformity of the materials, equipment and services to the requirements of the Memorandum entitled “Changes Required Pursuant to First Stage Evaluation” may be in the form of literature, drawings and data. The functional guarantees of any additional or varied materials, equipment and

services shall be stated in the applicable form in Section IV Bidding Forms.

(i) If the Bidder proposes to engage any Subcontractors additional to or different from those named in its first stage technical proposal for major items of supply or services as listed by the Employer in Section III, Evaluation and Qualification Criteria, which the Bidder intends to purchase or subcontract, the Bidder shall give details of the name and nationality of the proposed Subcontractors, including manufacturers, for each of those items. In addition, the Bidder shall include in its bid information establishing compliance with the requirements specified by the Employer for these items. Quoted rates and prices will be deemed to apply to whichever Subcontractor is appointed, and no adjustment of the rates and prices will be permitted.

(j) other documentation and information which may be **specified in the BDS.**

28. Letter of Bid, and Schedules

28.1 The Bidder shall complete the Letter of Bid and Schedules, including the appropriate Price Schedules, using the relevant forms furnished in Section IV, Bidding Forms. The forms must be completed as instructed in each form.

29. Bid Prices and Discounts

29.1 Unless otherwise **specified in the BDS,** bidders shall quote for the entire Works on a "single responsibility" basis such that the total bid price covers all the Contractor's obligations mentioned in or to be reasonably inferred from the bidding document in respect of the design, manufacture, including procurement and subcontracting (if any), delivery, construction, installation and completion of the Works. This includes all requirements under the Contractor's responsibilities for testing, pre-commissioning and commissioning of the Works and, where so required by the bidding document, the acquisition of all permits, approvals and licenses, etc.; the operation, maintenance and training services and such other items and services as may be specified in the Bidding Document, all in accordance with the requirements of the General Conditions. Items against which no price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items.

29.2 Bidders shall give a breakdown of the prices in the manner and detail called for in the Price Schedules (under Terms and Procedures for Payment) included in Section IV, Bidding Forms.

29.3 The prices shall be either fixed or adjustable as **specified in the BDS.**

29.4 In the case of **Fixed Price**, prices quoted by the Bidder shall be fixed during the Bidder's performance of the contract and not subject to variation on any account. A bid submitted with an adjustable price quotation will be treated as non responsive and rejected.

29.5 In the case of **Adjustable Price**, prices quoted by the Bidder shall be subject to adjustment during performance of the contract to reflect changes in the cost elements such as steel, cement, labour, fuel & lubricants and machinery & machine tools in accordance with the procedures specified in the corresponding Appendix to Tender in Section VIII, Part 3 of the bid documents.

29.6 If so indicated in ITB 1.1, bids are being invited for individual lots (contracts) or for any combination of lots (packages). Bidders wishing to offer any price reduction (discount) for the award of more than one Contract shall specify in their Letter of Bid the price reductions applicable to each package, or alternatively, to individual Contracts within the package, and the manner in which the price reductions will apply.

29.7 Bidders wishing to offer any unconditional discount shall specify in their Letter of Bid the offered discounts and the manner in which price discounts will apply.

29.8 **Unless otherwise specified in the BDS**, all duties, taxes and other levies payable by the Contractor under the contract, or for any other cause, as of the date 28 days prior to the deadline for submission of bids, shall be included in the total Bid Price submitted by the Bidder.

30. Currencies of Bid and Payment

30.1 The currency (ies) of the bid and the currency (ies) of payments shall be, as **specified in the BDS.**

30.2 Bidders may be required by the Employer to justify, to the Employer's satisfaction, their local and foreign currency requirements.

31. Period of Validity of Bids

31.1 Second Stage Bids shall remain valid for the period specified in the BDS after the bid submission deadline date prescribed by the Employer pursuant to ITB 35.1. **A bid valid for a shorter period shall be rejected by the Employer as non responsive.**

31.2 In exceptional circumstances, prior to the expiration of the bid validity period, the Employer may request Bidders to

extend the period of validity of their bids. The request and the responses shall be made in writing. If a bid security is requested in accordance with ITB 32, the Bidder granting the request shall also extend the bid security for twenty-eight (28) days beyond the deadline of the extended validity period. A Bidder may refuse the request without forfeiting its bid security. A Bidder granting the request shall not be required or permitted to modify its bid, except as provided in ITB 31.3.

31.3 In the case of fixed price contracts, if the award is delayed by a period exceeding fifty-six (56) days beyond the expiry of the initial bid validity, the Contract price shall be adjusted by a factor or factors specified in the request for extension. Bid evaluation shall be based on the Bid Price without taking into consideration the above correction.

32. Bid Security

32.1 The Bidder shall furnish as part of its bid, either a Bid-Securing Declaration or a bid security as specified in the BDS, in original form and in the amount **specified in the BDS.**

32.2 A Bid-Securing Declaration shall use the form included in Section IV Bidding Forms.

32.3 If a bid security is specified pursuant to ITB 32.1, the bid security shall be a demand guarantee in any of the following forms, unless otherwise specified in the BDS, at the Bidder's option,:

(a) an unconditional guarantee issued by a bank *or surety;*

(b) an irrevocable letter of credit;

(c) a cashier's or certified check; or

(d) another security **indicated in the BDS,**

from a reputable source from an eligible country. If the unconditional guarantee is issued by an insurance company or a bonding company located outside the Employer's Country, the issuer shall have a correspondent financial institution located in the Employer's Country to make it enforceable. In the case of a bank guarantee, the bid security shall be submitted either using the Bid Security Form included in Section IV, Bidding Forms or in another substantially similar format approved by the Employer prior to bid submission. In either case, the form must include the complete name of the Bidder. The bid security shall be valid for twenty-eight days (28) beyond the

original validity period of the bid, or beyond any period of extension if requested under ITB 31.2.

32.4 If a bid security is specified pursuant to ITB 32.1, any bid not accompanied by a substantially responsive bid security or Bid-Securing Declaration shall be rejected by the Employer as non responsive.

32.5 If a bid security is specified pursuant to ITB 32.1, the bid security of unsuccessful Bidders shall be returned as promptly as possible upon the successful Bidder's furnishing of the performance security pursuant to ITB 54.

32.6 The bid security of the successful Bidder shall be returned as promptly as possible once the successful Bidder has signed the Contract and furnished the required performance security.

32.7 The bid security may be forfeited or the Bid-Securing Declaration executed:

(a) if a Bidder withdraws its bid during the period of bid validity specified by the Bidder on the Letter of Bid, or

(b) if the successful Bidder fails to**:**

(i) sign the Contract in accordance with ITB 53; or

(ii) furnish a performance security in accordance with ITB 54.

32.8 The Bid Security or the Bid Securing Declaration of a JVA shall be in the name of the JVA that submits the bid. If the JVA has not been constituted into a legally enforceable JVA at the time of bidding, the Bid Security shall be in the names of all future partners as named in the letter of intent referred to in ITB 4.1.

32.9 If a Bid-Securing Declaration is executed in accordance with ITB 32.7, the Employer will declare the Bidder ineligible to be awarded a contract by the Employer for the period of time stated in the Form of Bid-Securing Declaration.

32.10 If a bid security is not required in the BDS, and

(a) if a Bidder withdraws its bid during the period of bid validity specified by the Bidder on the Letter of Bid Form, except as provided in ITB 32.2, or

(b) if the successful Bidder fails to: sign the Contract in accordance with ITB 53; or furnish a performance

security in accordance with ITB 54;

the Borrower may, **if provided for in the BDS**, declare the Bidder disqualified to be awarded a contract by the Employer for a period of time **as stated in the BDS**.

33. Format and Signing of Second Stage Bid

33.1 The Bidder shall prepare one original of the documents comprising the bid as described in ITB 27 and clearly mark it "SECOND STAGE BID - ORIGINAL." In addition, the Bidder shall submit copies of the bid, in the number **specified in the BDS** and clearly mark them "SECOND STAGE BID - COPY." In the event of any discrepancy between the original and the copies, the original shall prevail.

33.2 The original and all copies of the bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as **specified in the BDS** and shall be attached to the bid. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the bid where entries or amendments have been made shall be signed or initialed by the person signing the bid.

33.3 A bid submitted by a JVA shall comply with the following requirements:

(a) Unless not required in accordance with ITB 4.1 (a), be signed so as to be legally binding on all partners and

(b) Include the Representative's authorization referred to in ITB 4.1 (b), consisting of a power of attorney signed by those legally authorized to sign on behalf of the JVA.

33.4 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the bid.

E2. Second Stage Bids: Submission and Opening

34. Submission, Sealing and Marking of Second Stage Bids

34.1 Bidders may always submit their bids by mail or by hand. When so **specified in the BDS**, bidders shall have the option of submitting their bids electronically. Procedures for submission, sealing and marking are as follows:

34.2 Bidders submitting bids by mail or by hand shall enclose the original and each copy of the Bid, in separate sealed envelopes, duly marking the envelopes as "SECOND STAGE BID - ORIGINAL", and "SECOND STAGE BID - COPY." These

envelopes containing the original and the copies shall then be enclosed in one single envelope. The rest of the procedure shall be in accordance with ITB 34.2 and 34.3.

34.3 Bidders submitting bids electronically shall follow the electronic bid submission procedures **specified in the BDS**.

34.4 The inner and outer envelopes shall:

(a) bear the name and address of the Bidder;

(b) be addressed to the Employer in accordance with ITB 35.1;

(c) bear the specific identification of this bidding process indicated in the BDS 1.1; and

(d) bear a warning not to open before the time and date for bid opening.

34.5 If all envelopes are not sealed and marked as required, the Employer will assume no responsibility for the misplacement or premature opening of the bid.

35. Deadline for Submission of Second Stage Bids

35.1 Second Stage bids must be received by the Employer at the address and no later than the date and time indicated in the Letter of Invitation to submit Second Stage Bids.

35.2 The Employer may, at its discretion, extend the deadline for the submission of bids by amending the Bidding Document in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.

36. Late Bids

36.1 The Employer shall not consider any bid that arrives after the deadline for submission of bids, in accordance with ITB 35. Any bid received by the Employer after the deadline for submission of bids shall be declared late, rejected, and returned unopened to the Bidder.

37. Withdrawal, Substitution, and Modification of Second Stage Bids

37.1 A Bidder may withdraw, substitute, or modify its bid after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the authorization in accordance with ITB 33.2, (except that withdrawal notices do not require copies). The corresponding substitution or modification of the bid must accompany the respective written notice. All notices must be:

(a) prepared and submitted in accordance with ITB 33 and ITB 34 (except that withdrawals notices do not require copies), and in addition, the respective envelopes shall

be clearly marked "SECOND STAGE BID - WITHDRAWAL," "SECOND STAGE BID - SUBSTITUTION," "SECOND STAGE BID - MODIFICATION;" and

(b) received by the Employer prior to the deadline prescribed for submission of bids, in accordance with ITB 35

37.2 Bids requested to be withdrawn in accordance with ITB 37.1 shall be returned unopened to the Bidders.

37.3 No bid may be withdrawn, substituted, or modified in the interval between the deadline for submission of Second Stage bids and the expiration of the period of bid validity specified by the Bidder on the Letter of Bid or any extension thereof.

38. Second Stage Bid Opening

38.1 The Employer shall conduct the Second Stage bid opening in public, in the presence of Bidders` designated representatives and anyone who choose to attend, and at the address, date and time specified in the Letter of Invitation to submit Second Stage Bids. Any specific electronic bid opening procedures required if electronic bidding is permitted in accordance with ITB 34.1, shall be as **specified in the BDS.**

38.2 First, envelopes marked "SECOND STAGE BID - WITHDRAWAL" shall be opened and read out and the envelope with the corresponding bid shall not be opened, but returned to the Bidder. No bid withdrawal shall be permitted unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is read out at bid opening. Next, envelopes marked "SECOND STAGE BID - SUBSTITUTION" shall be opened and read out and exchanged with the corresponding bid being substituted, and the substituted bid shall not be opened, but returned to the Bidder. No bid substitution shall be permitted unless the corresponding substitution notice contains a valid authorization to request the substitution and is read out at bid opening. Envelopes marked "SECOND STAGE BID - MODIFICATION" shall be opened and read out with the corresponding bid. No bid modification shall be permitted unless the corresponding modification notice contains a valid authorization to request the modification and is read out at bid opening. Only bids that are opened and read out at bid opening shall be considered further.

38.3 All other envelopes shall be opened one at a time, reading out: the name of the Bidder and the Bid Price(s), including any discounts, and indicating whether there is a modification; the presence or absence of a bid security or a

Bid-Securing Declaration; and any other details as the Employer may consider appropriate. Only discounts read out at bid opening shall be considered for evaluation. No bid shall be rejected at bid opening except for late bids, in accordance with ITB 36.1.

38.4 The Employer shall prepare a record of the bid opening that shall include, as a minimum: the name of the Bidder and whether there is a withdrawal, substitution, or modification; the Bid Price, per lot if applicable, including any discounts; and the presence or absence of a bid security or a Bid-Securing Declaration. The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Bidders who submitted bids in time, and posted online when electronic bidding is permitted.

E3. Second Stage Bids: Evaluation and Comparison

39. Confidentiality

39.1 Consistent with the requirements of transparency and intellectual property rights, in revising the Second Stage Technical Proposal, information contained in the Bidder's Technical Proposal reviewed in the first stage shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on contract award is communicated to all Bidders,.

39.2 Any attempt by a Bidder to influence the Employer in the evaluation of the first and second stage bids or Contract award decisions may result in the rejection of its bid.

39.3 Notwithstanding ITB 39.2, from the time of First Stage technical proposal opening to the time of Contract award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it should do so in writing.

40. Clarification of Bids

40.1 To assist in the examination, evaluation, and comparison of the bids, and qualification of the Bidders, the Employer may, at its discretion, ask any Bidder for a clarification of its bid. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing. No change in the prices or substance of the bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the bids, in accordance with ITB 44.1.

40.2 If a Bidder does not provide clarifications of its bid by the date and time set in the Employer's request for clarification, its bid may be rejected.

41. Deviations, Reservations, and Omissions

41.1 During the evaluation of bids, the following definitions apply:

(a) "Deviation" is a departure from the requirements specified in the Bidding Document;

(b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Document; and

(c) "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Document.

42. Determination of Responsiveness

42.1 The Employer's determination of a bid's responsiveness is to be based on the contents of the bid itself, as defined in ITB 27.

42.2 A substantially responsive bid is one that meets the requirements of the Bidding Document and has properly incorporated all modifications listed in the Memorandum *entitled "Changes Required Pursuant to First Stage Evaluation"*, without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that,

(a) if accepted, would:

(i)affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or

(ii) limit in any substantial way, inconsistent with the Bidding Document, the Employer's rights or the Bidder's obligations under the proposed Contract; or

(b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive bids.

42.3 A Second Stage bid containing technical or commercial alternatives not submitted as part of the first stage technical proposal will be treated as non responsive.

42.4 If a bid is not substantially responsive to the requirements of the Bidding Document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or

omission.

43. Nonmaterial Nonconformities

43.1 Provided that a bid is substantially responsive, the Employer may waive any nonconformities in the bid that do not constitute a material deviation, reservation or omission.

43.2 Provided that a bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify quantifiable nonmaterial nonconformities in the bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the price of the bid. Failure of the Bidder to comply with the request may result in the rejection of its bid.

43.3 Provided that a bid is substantially responsive, the Employer shall rectify nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment shall be made using the method indicated in Section III, Evaluation and Qualification Criteria.

44. Correction of Arithmetical Errors

44.1 Provided that the bid is substantially responsive, the Employer shall correct arithmetical errors on the following basis:

(a) where there are errors between the total of the amounts given under the column for the price breakdown and the amount given under the Total Price, the former shall prevail and the latter will be corrected accordingly;

(b) if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) above.

44.2 If the Bidder that submitted the lowest evaluated bid does not accept the correction of errors, its bid shall be declared non-responsive.

45. Conversion to Single Currency

45.1 For evaluation and comparison purposes, the currency (ies) of the bid shall be converted into a single currency as **specified in the BDS.**

46. Margin of Preference

46.1 No margin of domestic preference shall apply.

47. Evaluation of Second Stage Bids

47.1 The Employer shall use the criteria and methodologies indicated in this Clause. No other evaluation criteria or methodologies shall be permitted.

Technical Evaluation

47.2 The Employer will carry out a detailed evaluation of the Second Stage bids not previously rejected to determine whether the technical aspects concerning the modifications to the technically acceptable base or alternative bid detailed in the Memorandum entitled "Changes Required Pursuant to First Stage Evaluation", pursuant to ITB 26.1, have been properly addressed and are substantially responsive to the requirements set forth in the Bidding Document.

Economic Evaluation

47.3 To evaluate a bid, the Employer shall consider the following:

(a) the bid price, excluding provisional sums and the provision, if any, for contingencies in the Price Schedules;

(b) price adjustment for correction of arithmetic errors in accordance with ITB 44.1;

(c) price adjustment due to discounts offered in accordance with ITB 29.6 and ITB 29.7;

(d) price adjustment due to quantifiable nonmaterial nonconformities in accordance with ITB 43.3;

(e) converting the amount resulting from applying (a) to (d) above, if relevant, to a single currency in accordance with ITB 45; and

(f) the evaluation factors, if any, indicated in Section III, Evaluation and Qualification Criteria.

47.4 If price adjustment is allowed in accordance with ITB 29.3, the estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in bid evaluation.

47.5 If this Bidding Document allows Bidders to quote separate prices for different lots (contracts), and the award to a single Bidder of multiple lots (contracts), the methodology to determine the lowest evaluated price of the lot (contract) combinations, including any discounts offered in the Letter of Bid, is specified in Section III, Evaluation and Qualification Criteria.

48. Comparison of Bids

48.1 The Employer shall compare all substantially responsive bids in accordance with ITB 47.3 to determine the lowest evaluated bid.

49. Qualification of the Bidder

49.1 The Employer shall determine to its satisfaction whether the Bidder that is selected as having submitted the lowest evaluated and substantially responsive bid still meets the qualifying criteria specified in Section III, Evaluation and Qualification Criteria.

49.2 An affirmative determination shall be a prerequisite for award of the Contract to the Bidder. A negative determination shall result in disqualification of the bid, in which event the Employer shall proceed to the next lowest evaluated bid to make a similar determination of that Bidder's qualifications to perform satisfactorily.

49.3 The participation of the manufacturers and subcontractors proposed in its Bid to be used by the lowest evaluated Bidder should be confirmed with a letter of intent between the parties, as needed. The capabilities of additional or different manufacturers and subcontractors proposed in its Bid to be used by the lowest evaluated Bidder will also be evaluated for acceptability in accordance with Section III, Evaluation and Qualification Criteria. Should any additional or substitute manufacturer or subcontractor be determined to be unacceptable, the Bid will not be rejected, but the Bidder will be required to substitute an acceptable manufacturer or subcontractor without any change to the bid price. Prior to signing the Contract, the corresponding Appendix to the Contract Agreement shall be completed, listing the approved manufacturers or subcontractors for each item concerned.

50. Employer's Right to Accept Any Bid, and to Reject Any or All Bids

50.1 The Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids at any time prior to contract award, without thereby incurring any liability to Bidders. In case of annulment, all bids submitted and specifically, bid securities, shall be promptly returned to the Bidders.

F. Award of Contract

51. Award Criteria

51.1 Subject to ITB 50.1, the Employer shall award the Contract to the Bidder whose offer has been determined to be the lowest evaluated bid and is substantially responsive to the Bidding Document, provided further that the Bidder is determined to be eligible and qualified to perform the Contract satisfactorily.

52. Notification of Award

52.1 Prior to the expiration of the period of bid validity, the Employer shall notify the successful Bidder, in writing, that its bid has been accepted. The notification letter (hereinafter and in the Conditions of Contract and Contract Forms called the "Letter of Acceptance") shall specify the sum that the Employer will pay the Contractor in consideration of the execution and completion of the Works (hereinafter and in the Conditions of Contract and Contract Forms called "the Contract Price").

52.2 At the same time, the Employer shall also notify all other Bidders of the results of the bidding, and shall publish in UNDB online and in the dgMarket the results identifying the bid and lot numbers and the following information: (i) name of each Bidder who submitted a Bid; (ii) bid prices as read out at Bid Opening; (iii) name and evaluated prices of each Bid that was evaluated; (iv) name of bidders whose bids were rejected and the reasons for their rejection; and (v) name of the winning Bidder, and the Price it offered, as well as the duration and summary scope of the contract awarded.

52.3 Until a formal contract is prepared and executed, the notification of award shall constitute a binding Contract.

52.4 The Employer shall promptly respond in writing to any unsuccessful Bidder who, after notification of award in accordance with ITB 52.1, requests in writing the grounds on which its bid was not selected.

53. Signing of Contract

53.1 Promptly upon notification, the Employer shall send the successful Bidder the Contract Agreement.

53.2 Within twenty-eight (28) days of receipt of the Contract Agreement, the successful Bidder shall sign, date, and return it to the Employer.

53.3 Notwithstanding ITB 53.2 above, in case signing of the Contract Agreement is prevented by any export restrictions attributable to the Employer, to the country of the Employer, or to the use of the materials, equipment and services to be supplied, where such export restrictions arise from trade regulations from a country supplying those materials, equipment and services , the Bidder shall not be bound by its bid, always provided, however, that the Bidder can demonstrate to the satisfaction of the Employer and of the Bank that signing of the Contact Agreement has not been prevented by any lack of diligence on the part of the Bidder in completing any formalities, including applying for permits, authorizations and licenses necessary for the export of the materials , equipment and services

under the terms of the Contract.

54. Performance Security

54.1 Within twenty-eight (28) days of the receipt of notification of award from the Employer, the successful Bidder shall furnish the performance security in accordance with the General Conditions of Contract, using for that purpose the Performance Security Form included in CF-03, Section IX, Contract Forms, or another form acceptable to the Employer. If the performance security furnished by the successful Bidder is in the form of a bond, it shall be issued by a bonding or insurance company that has been determined by the successful Bidder to be acceptable to the Employer. A foreign institution providing a bond shall have a correspondent financial institution located in the Employer's Country.

54.2 Failure of the successful Bidder to submit the above-mentioned Performance Security or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security. In that event the Employer may award the Contract to the next lowest evaluated Bidder whose offer is substantially responsive and is determined by the Employer to be qualified to perform the Contract satisfactorily.

Section II. Bid Data Sheet

A. General

ITB 1.1 — **The number of the Invitation for Bids is:** HQ/S&T/EC/D-B/ Mughalsarai-New Bhaupur dated 30.03.2015

ITB 1.1 — **The Employer is:** Dedicated Freight Corridor Corporation of India Limited (DFCCIL)

ITB 1.1

The name of the ICB is: Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

The identification number of the ICB is: HQ/S&T/EC/D-B/Mughalsarai-New Bhaupur.

The ICB comprises only 1 (one) number of Contract Package, brief details of which are given in the following table:

Contract Package No.	Existing Railway KM / DFC Chainage		Approximate Total Route Length	Remarks
	From	To		
203	Km 669.670 (Ch. 119.550)	Km – (Ch. 507.693)	388.143 (DL) 29.150 (SL)	Parallel Length (Double Line) –261.874 Km Detour Length (Double Line) – 126.269 Km Link Line Length (Single Line) – 29.150 Km*

* New Ahraura Road to Jeonathpur – 8.73 Km

* New Karchana to Cheoki - 4.8 Km

* New Karchana to Iradatganj - 8.9 Km

* New Kanpur to Rooma – 4.04 Km

* New Bhimsen to Bhimsen – 2.68 Km

For further details, refer to Part-4 Reference Documents Site data

ITB 2.1	**The Borrower is:** Dedicated Freight Corridor Corporation of India Ltd.
ITB 2.1	**The name of the Project is:** Eastern Dedicated Freight Corridor Project-2
ITB 4.3 (f)	**The name of Consultant to the Employer is:** AECOM Asia Company Ltd. Hong Kong 'AECOM' is providing 'Engineering Consultancy Services' to the Employer, for the Mughalsarai-New Bhaupur (EDFC-2) and Dadri-Khurja-Ludhiana (EDFC-3) Sections of Dedicated Freight Corridor.
ITB 4.3 (g)	The appointment of Project Management Consultant for the supervision of the above sections is under process and shall be intimated later.
B. Contents of Bidding Document	
ITB 7.1	For **clarification purposes only**, the Employer's address is: **Dedicated Freight Corridor Corporation of India Limited**, Metro Station Building Complex, Pragati Maidan, 4th Floor, Room No. 402 B, New Delhi, 110001, India **Attention:** Mr. Sarvesh Singh, Group General Manager / S&T-I/ EC **Telephone:** +91 11 2345 4860/23379148 **Facsimile number:** + 91 11 2345 4862 **Electronic mail address:** sarveshsingh@dfcc.co.in **The official website of the Employer is** www.dfccil.gov.in
ITB 7.2	Add the following to ITB 7.2: The Bidder is also advised to refer clause 1.9 of General Conditions of Contract
ITB 7.4	A Pre-Bid meeting will take place at the following date, time and place: **Date:** 28.04.2015 **Time: 15:00 Hrs** **Place:** Conference Room, 4th Floor, Dedicated Freight Corridor Corporation of India Limited**,** Metro Station Building Complex, Pragati Maidan, New Delhi – 110 001 Bidders can provide their request for clarification by mail at

<table>
<tr><td></td><td>sarveshsingh@dfcc.co.in or in paper copies. In addition they are advised to provide an editable soft copy (MS Word) of the queries raised by them.

The Bidders are also advised to use the following format for their queries:

<table>
<tr><th>Query No.</th><th>Reference to Bid Document (Clause / Para No. & Page No.)</th><th>Brief Description of Clause / Para No.</th><th>Query Raised</th></tr>
<tr><td>1.</td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td><td></td></tr>
<tr><td>etc.</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>ITB 7.6</td><td>Minutes of pre-bid meeting shall be intimated only through e-mail to all the bidders, who have purchased the Bid Document from DFCCIL or submitted queries for clarifications. Minutes of pre-bid meeting shall be uploaded on DFCC web site (www.dfccil.gov.in) also.</td></tr>
<tr><td>ITB 8.2</td><td>Addenda to bidding documents shall be intimated only through e-mail to all the bidders, who have purchased the Bid Document from DFCCIL or submitted queries for clarifications. Addenda to bidding documents shall be uploaded on DFCC web site (www.dfccil.gov.in) also.</td></tr>
<tr><td>ITB 10.1</td><td>The language of the bid is: English.</td></tr>
<tr><td colspan="2">C1. First Stage Technical Proposals: Preparation</td></tr>
<tr><td>ITB 11.1 (b)</td><td>Delete paragraph 11.1 (b)</td></tr>
<tr><td>ITB 11.1 (i)</td><td>The Bidder shall submit, with its First Stage Technical Proposal, the following documents:

(a) The bidder shall submit the documents as listed in Annexure-1, Section III- Qualification and Evaluation Criteria.

(b) In case, the Bidder wishes to replace any specialized sub-contractor(s) already approved by Employer through Pre-qualification process, the Bidder shall submit the details establishing compliance of the proposed specialized sub-contractor with the requirement specified in the Pre-qualification document.</td></tr>
<tr><td>ITB 13.1</td><td>Bidders are not permitted to propose any technical alternatives.</td></tr>
</table>

ITB 17.1	**In addition to the original of the First Stage Technical Proposal, the number of copies is:** 3 (three). In addition, 2 (two) soft copy (read only) of the bid shall be submitted. The document submission shall be in spiral / hard bound form only. The Bidders are advised not to submit loose sheets in plastic folders. The Bidders are further advised to machine number all the pages and prepare a table of contents in the beginning of each volume of documents referring the page numbers of the indexed items. The Bidders are also advised to ensure that each paper of the submitted Bid is signed by the legally Authorised Representative of the Bidder.
ITB 17.2	**The written confirmation of authorization to sign on behalf of the Bidder shall consist of:** Legally authorized power of attorney.
C2. First Stage Technical Proposals: Submission and Opening	
ITB 18.1 & ITB 18.1 (b)	Bidders **do not** have the option of submitting their First Stage Technical Proposal electronically.
ITB 19.1	For First Stage Technical Proposal, **for submission purposes** only, the Employer's address is : **Dedicated Freight Corridor Corporation of India Limited**, Metro Station Building Complex, Pragati Maidan 4th Floor, Room No. 402 B, New Delhi, 110001 India **Attention:** Mr. Sarvesh Singh, Group General Manager / S&T-I/ EC **Telephone:** +91 11 2345 4860/23379148 **Facsimile number:** + 91 11 2345 4862 **Electronic mail address:** sarveshsingh@dfcc.co.in **The deadline for submission of First Stage Technical Proposals is:** **Date:** 29.05.2015 **Time:** 15:00 Hrs
ITB 21.1	**The opening of First Stage Technical Proposals shall take place at:** Dedicated Freight Corridor Corporation of India Limited, Metro Station Building Complex, Pragati Maidan **4th Floor Conference Hall**

	New Delhi, 110001 India **Date:** *29.05.2015* **Time:** *15:30 Hrs*
	E1. Second Stage Bid Preparation
ITB 23.1 (b)	Replace the words "Appendix to Contract Agreement" with "Appendix to Tender". Alternative time for completion proposed, if any, by the Bidders shall not be accepted.
ITB 24.4	Add the following after the ITB 24.4: "In case, the Bidder has proposed to replace any specialized sub-contractor(s) already approved by the Employer through the Pre-qualification process, the Employer shall determine to its satisfaction that the bidder still meets the qualification criteria specified in Section III, Evaluation and Qualification Criteria."
ITB 27.1 (d)	In Section I, ITB 27.1 (d) has been mentioned twice. Second "27.1 (d)" should be read as 27.1 (e).
ITB 27.1 (k)	Below ITB 27.1 (j), add new paragraph ITB 27.1 (k) with the following contents: "In case, the Bidder wishes to replace any specialized sub-contractor(s) already approved by the Employer through Pre-qualification process/during First Stage Technical Evaluation, the Bidder shall submit the details establishing compliance of the proposed specialized sub-contractor(s) with the requirement specified in the Pre-qualification document."
ITB 29.1	Bidder shall quote for the entire Works on a single responsibility basis. The price shall be quoted only in the Letter of Bid-Two Stage Bidding, Second Stage Bid (LOB-SS) Section IV, Bidding Forms, Part 1 of the Bidding Documents.
ITB 29.3	The prices quoted by the Bidder shall be adjustable.
ITB 29.8	Add the following after ITB 29.8: "The bidders may note that this DFCC project being funded by the World Bank, qualifies for exemption from payment of Customs Duty and Excise Duty on goods supplied / intended to be supplied to the

	project in terms of Government of India's Notification no. 84/97 – customs dated 11.11.1997 and Central Excise Notification no. 108/95-C E Dated 28.08.1995 (read with all subsequent amendments including amendment dated 01.03.2008) respectively. Service Tax department vide their Notification No. 25/2012-Service Tax dated 20.06.2012, has exempted the services by way of construction, erection, commissioning, or installation of original works pertaining to railways. The Bidder shall examine to make his own assessment in regard to service tax liability in the Contract. No separate Service Tax reimbursement will be made by the Employer. However, while quoting the bid price, bidders are advised to ascertain exemptions of custom & excise duty and / or availability of deemed export benefits for goods required as inputs for completion of the Works under the World Bank Funded Projects. The bidders are also advised to ascertain the availability of the custom / excise exemptions for the goods supplied by their subcontractors used as input for the construction of Works. In this regard bidders' attention is also drawn to sub-clause 4.11 of the Particular Conditions.", Section VIII, Part 3 of the Bidding Documents."
ITB 30.1	The currency(ies) of the bid and the payment currency (ies) shall be as described below: a) The prices shall be quoted by the Bidder entirely in Indian Rupees (the name of the currency of Employer's country) and further referred to as "the local currency". A Bidder expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Employer's country (referred to as "the foreign currency requirements") shall indicate the percentage (s) of the Bid Price in the Appendix to Bid, Section IV, Bidding Forms, Part 1 of Bidding Documents, needed by him for the payment of such foreign currency requirements, limited to no more than three foreign currencies. b) For the purpose of conversion of foreign currency in to local currency i.e. Indian Rupees (INR) or vice versa, Bidders shall use the Reference Rates of Foreign Currency published by Reserve Bank of India (www.rbi.org.in), on the Base Date (28 days prior to the last date of second stage bid submission) In case a particular currency rate is not published by Reserve Bank of India, then the selling rate of such currency shall be taken from

	the following internet web site on the Base Date: http://www.oanda.com In case the exchange rates are not available on the above website also, then mid-market rate of such currency shall be taken from the alternate web site http://www.xe.com for the same date. c) In respect of procurement of goods and services from off shore sources Indian cost indices shall not apply but wholesale cost index for the relevant input of the respective country shall apply. In case a published index for such goods or services is not available, the wholesale prices index of relevant category of the respective country shall be used. The rates of exchange as mentioned above shall apply for all payments under the Contract so that no exchange risk will be borne by the successful bidder.
ITB 30.2	Foreign currency requirements shall be indicated only in respect of those goods and services which the bidder expects to procure from offshore sources.
ITB 31.1	The bid validity period shall be 120 days from last date of bid submission.
ITB 32.1	Bid security shall be submitted with the Second stage bid and shall be *INR 50 Million*.
ITB 32.3	The bid security shall be an unconditional guarantee issued by a reputed bank from an Eligible country.
ITB 33.1	The bidder shall submit 1 (one) original and 3 (three) copies of the Bid. In addition, one soft copy (read only) of the bid shall also be submitted. The document submission shall be in spiral / hard bound form only. The Bidders are advised not to submit loose sheets in plastic folders. Bidders are advised to initial each paper of their submitted bid. The Bidders are further advised to machine number all the pages and prepare a table of contents in the beginning of each volume of documents referring the page numbers of the indexed items.
ITB 33.2	The written confirmation of authorization to sign on behalf of the Bidder shall consist of: Legally authorized power of attorney

E2. Second Stage Bids: Submission and Opening	
ITB 34.1 & ITB 34.3	Bidders **shall not** have the option of submitting their bids electronically.
E3. Second Stage Bids: Evaluation and Comparison	
ITB 47.3 (a)	Provisional Sum and Contingencies under this Contract are NIL
ITB 49.3	Replace the words "Appendix to Contract Agreement" with "Appendix to Tender". Add the following at the end of ITB 49.3: "In case, the Bidder has proposed to replace any specialized sub-contractor(s) already approved by Employer through the Pre-qualification process and/or during First Stage Technical Evaluation, the Employer shall determine to its satisfaction that the bidder still meets the qualification criteria specified in Section III, Evaluation and Qualification Criteria."
ITB 54.1	The Performance Security shall be an unconditional guarantee issued by a scheduled bank in India (included in the second schedule to Reserve Bank of India Act 1934) or the corresponding financial institution of foreign bank located in India. Bond is not acceptable as Performance Security.

Section III. Evaluation and Qualification Criteria

The purpose of this Section is to establish that the Bidder continues to meet the criteria used at the time of prequalification. It contains all the criteria that the Employer shall use to evaluate bids and qualify Bidders in accordance with ITB 23, ITB 47 and ITB 49. The Bidder shall provide all the information requested in this section as well as in the forms included in Section IV, Bidding Forms.

First Stage Technical Proposals

1. Evaluation

The documents required for submission and evaluation of First Stage Technical Proposal are detailed in Annexure-I of this section. In addition, the following factors shall apply in proposal evaluation.

2. Qualification

2.1 Updation of Information

The Bidder and any subcontractors shall continue to meet the criteria used at the time of prequalification and shall give an undertaking to this effect. The Bidder shall fill up Form number ELI 1.1 and ELI 1.2 included in Section IV, Bidding Forms, Part 1 of Bidding Documents.

2.2 Financial Resources

Using Form No FIN 3.3 in Section IV, Bidding Forms, the Bidder must demonstrate meeting the following cash-flow requirements:

- US $ 12 (Twelve) million for the subject contract

Bidder should meet the above cash flow requirement as indicated in paragraph 3.1 (i) of Section (III) - Eligibility and Qualification criteria of Prequalification Document issued on 19th February 2014 for this bid and as modified, if any, through addendum.

The Audited Financial Statements of the latest completed Financial Years (as required in paragraph 3.1 of Section III - Eligibility and Qualification criteria of Prequalification Document) are to be submitted.

2.3 Personnel

The Bidder shall propose to arrange the following minimum key personnel during the execution of work for each lot:

SN	Key Position	Minimum Qualifying Requirement		
		Total Work Experience (years)	Experience in Similar Works (years)	Minimum Education Qualification
1.	Project Director** (Signalling & Telecommunication)	20	7	B.E. (Electrical / Electronics)
2.	Sr. Design Engineer* (Signalling)	15	5	B.E. (Electrical / Electronics)
3.	Sr. Design Engineer * (Telecommunication)	15	5	B.E. (Electronics / Telecommunication)
4.	System Integrator	15	5	B.E. (Electrical / Electronics)
5.	Interface Manager	15	7	B.E. (Civil / Electrical / Electronics / Telecommunication)
6.	Project Manager (Signalling)	15	5	B.E. (Electrical / Electronics)
7.	Project Manager (Telecommunication)	15	5	B.E. (Electrical / Electronics / Telecommunication)
8.	Planner & Scheduler	15	5	B. Tech. or any other Science Graduate (should be well conversant with Primavera or similar software)

SN	Key Position	Minimum Qualifying Requirement		
		Total Work Experience (years)	Experience in Similar Works (years)	Minimum Education Qualification
9.	Quality Control Expert	15	5	B.E. (Electrical / Electronics)
10.	Systems Safety Expert	15	5	Engineering Graduate (Electrical / Electronics) with Diploma/ Specialization in Safety related field.
11.	RAMS Expert	15	5	Engineering Graduate with Diploma/ Specialization in RAMS.
12.	Train Management System Expert	15	5	B.E. (Electronics / Telecommunication/Electrical)

*Minimum 3 (three) years outside India experience in at least one Project

**Minimum 5 (five) years outside India experience in at least two Projects

The Bidder shall provide details of the proposed personnel and their experience records in the Form number PER -1 and PER - 2 included in Section IV, Bidding Forms.

Note:

The Bidders are advised NOT to submit more than one CV against each of the above mentioned key positions. In case more than one CV is submitted for any key position, such additional CV(s) shall not be considered for evaluation purposes and only the first CV in the bidding document would be considered for evaluation.

2.4 Equipment

The Bidder shall demonstrate that it will have access to essential equipment /plants during the execution of Works. Capacity and number of machines shall be commensurate with the Works program submitted by the Bidder to enable him to finish the work in stipulated time. The Bidder shall provide ownership/renting/leasing/ arrangement details of proposed items of equipment using Form number EQU in Section IV of Bidding Document.

SN	Name of Equipment / Software	Number(s)*
1.	Cable Trencher	
2.	Trenchless cabling equipment	
3.	Auto fusion splicing machine	

* Appropriate number(s) to be filled by the Bidder based on the methodology.

Note:

The above 'List of Equipment /Plants' is indicative only. The Bidders' are advised to refer to Sub-Clause 4.17 [Contractor's Equipment] of the Conditions of Contract pursuant to which the Contractor shall be responsible for all Contractors' Equipment.

2.5 Subcontractors and Suppliers

Subcontractors for major items of supply or services identified in the prequalification document must continue to meet the minimum criteria specified therein for each item.

The Bidder shall demonstrate in its proposal clearly the work and value (in terms of percentage of the approximate total value of the Contract) of that work to be carried out by its main subcontractors, including its proposed designer if the Design is not to be carried out in-house.

Where the Bidder intends to utilize materials, equipment & plants and services including design services procured from subcontractors / suppliers, it should outline such materials and equipment to be procured, in Form SUP, provided in Section IV.

In the case of a Bidder who offers to supply and/or install plant and equipment/ component/ software under the contract that the Bidder does not manufacture or otherwise produce and/or install, the Bidder shall provide the manufacturer's authorization, using the Form Manufacturer's Authorization provided in Section IV, Part 1 showing that the Bidder has been duly authorized by the manufacturer or producer of the related plant and equipment or component to supply and/or install that item in the

Employer's country. The Bidder is responsible for ensuring that the manufacturer or producer complies with the requirements of ITB 4 and 5.

3. Second Stage Bid

3.1. Evaluation

The evaluation of the Second Stage bid shall be carried out in accordance with the provisions of ITB 47. Bidders shall submit Second Stage Bid as per the Form - LOB –SS Bidding Forms-Section IV.

3.2. Evaluation of non-material non conformities as per ITB 43.3

Non material non conformities related to the Bid Price will be evaluated considering price implication for the same based upon current market rate/ rate analysis. Decision of employer regarding evaluation of nonmaterial non conformities shall be final and binding on the bidder.

3.3 Time Schedule for Completion of Works:

The designated period for the completion and taking over the entire Works shall be 1000 days (One Thousand Days) from the Commencement Date, as indicated with further details in Para 8.2, Appendix to Tender, Part 3, Section VIII of these Bidding Documents. Bidders shall confirm that their First Stage Technical Proposals and subsequently, their Second Stage Bids are based on this Time Schedule for Completion. No credit of any kind will be given in the evaluation of Technical Proposals and Second Stage Bids to a Proposal and/ or a Bid offering to complete the Works earlier than this designated period. However, Technical Proposals and Second Stage Bids offering to complete the Works later than this designated period shall be rejected by the Employer.

Annexure- I

Documents Required For Bid Submission and Evaluation

of

First Stage Technical Proposal

1 Type of Contract

First Stage Technical Proposals, followed by Second Stage Bids, are being invited for a Lump-Sum Contract for Design and Construction, based on the Employer's Requirements. The detailed design of all components of the freight railway will be carried out by the Contractor based on the technical standards and specifications prescribed in Part 2- Employers' Requirements. The Conditions of Contract will be based on the "Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Plant, and for Building and Engineering Works Designed by the Contractor'' First Edition 1999 published by the Fédération Internationale des Ingénieurs-Conseils (FIDIC).

2 Documents Required for First Stage Technical Proposal

The First Stage Technical Proposal will comprise of the following documents including the documents required as per Clause ITB 11:

2.1 General Submittal

	TO BE SUBMITTED			
	Documents	By Sole Bidder	By JV	Remarks
(a)	Proposal Letter Two Stage Bidding: First Stage Technical Proposal – (Form – LOB –FS, Bidding Forms-Section IV)	√	√	
(b)	Power of Attorney to submit Bid (Form POA-1, Bidding Forms-Section IV);	√	√	
(c)	Power of Attorney to Authorized Representative of Joint Venture (Form POA-2, Bidding Forms-Section IV);	×	√	
(d)	Proforma Letter of Participation from Each Member of Joint Venture (Form LOP, Bidding Forms-Section IV);	×	√	To be submitted by each member of the JV

	TO BE SUBMITTED			
	Documents	By Sole Bidder	By JV	Remarks
(e)	Memorandum of Understanding (Form MOU – Bidding Forms-Section IV);	×	√	
(f)	Bidder Information (Form ELI 1.1 – Bidding Forms-Section IV);	√	√	
(g)	Bidder Party Information (Form ELI 1.2 – Bidding Forms-Section IV);	Only by each proposed Specialized Subcontractor	By each member of the JV and each proposed Specialized Subcontractor	Form ELI-1.2, is also to be submitted for each proposed Specialized Subcontractor.
(h)	Undertaking as required vide para 2.1 Section III Evaluation and Qualification Criteria (FORM-UND, Bidding Forms-Section IV);	√	√	
(i)	Financial Resources (FIN 3.3 – Bidding Forms-Section IV);	√	√	To be submitted for each member of the JV
(j)	Current Contract Commitments / Works in Progress (Form CCC, Bidding Forms-Section IV);	√	√	To be submitted for each member of the JV
(k)	Schedule of Suppliers (Form SUP – Bidding Forms-Section IV);	√	√	
(l)	Undertaking of Copyright (Form CU –Bidding Forms-Section IV);	√	√	
(m)	Manufacturers' Authorisation (FORM-MA, Bidding Forms-Section IV)	√	√	To be submitted by all authorised manufacturers proposed by the

	TO BE SUBMITTED			
	Documents	By Sole Bidder	By JV	Remarks
				bidder
(n)	Technical Submittals pursuant to clause 2.2 of Annexure-I of Section III, Evaluation and Qualification Criteria.	√	√	

2. 2 Technical Submittal

1) Methods Statement

The Bidder shall submit a methods statement which demonstrates the Bidder's understanding of the Project and comprehension of the Works involved. In this methods statement, the Bidder shall submit *inter alia* a detailed plan for Design, layout, installation, construction, testing & commissioning and handing over the completed Works to the Employer in strict compliance with the Contract requirements. This shall correspond to Site organization, Contractor's equipment, construction schedule and Work Plan being submitted by the Bidder as a part of bid documents.

2) Organization and Management

The Bidder shall submit an organization chart identifying the management and reporting structure for key positions and all site teams. The Bidder shall submit a commentary that describes the roles and responsibilities of the various key positions in the organization structure, the minimum qualifications, channels of communication, organization they come from and how this organization structure will manage the execution of the works within the scheduled period. The names and CV's of key staff in the organization chart shall be included, and referenced to forms **PER-1 & 2** in Section IV, Bidding Forms.

3) Work Plan

The Bidder shall submit an Outline Work Plan which shall indicate how the Bidder intends to organize and carry out the Works, achieve Stages and complete the whole of the Works by the appropriate key dates. The Work Plan shall be prepared in terms of weeks from the Date of Commencement of Works, taking D as the Commencement Date and other time schedules marked in D+ format. Bidders are required to provide details of Contractor's Equipment in **Form EQU** as per Bidding Form included in Section IV**.**

(Refer to Explanatory Note 1 at the end of this Section)

4) Documents for Safety, Quality and Environmental Plans

The Bidder shall submit the following documents, which shall demonstrate clearly the Bidder's proposals for achieving effective and efficient Safety, Quality and Environment protection procedures.

a) Outline Safety Plan

b) Outline Quality Plan

c) Outline Environmental Plan

(Refer to Explanatory Note 2 at the end of this Section)

5) Employer's Requirements Compliance

The Bidder shall submit details of compliance with the Employers' Requirements as listed in Part 2 of bidding document. This shall be done in a tabular format on a section by section basis and detail how the compliance is achieved.

6) The Bidder shall submit detailed proposal for implementing security of Data Networking System in compliance with clause 6.6 of PS/Telecommunication Works.

*****

Explanatory Note No. 1

Reference Paragraph 2.2 (3) Work Plan : Requirements of Work Plan

(1) The Work Plan shall show how the Bidder proposes to organize and carry out the Works and to achieve Stages and complete the whole of the Works by the given Key Dates/Milestones. This may be in the form of an Excel spread sheet/ Primavera or similar program output.

(2) The Work Plan shall follow the instructions given in **Part 2, Section VI, ", Volume 1: General Specifications, Chapter 4, PROJECT PROGRAM REQUIREMENTS"**

(3) The Work Plan shall show achievement of all Key Dates and Works Area Access Dates. The Works Programme shall also show Milestones, but the Milestones shall not be taken as imposing any constraints that in any way affect the logic or limit any other dates in the Programme.

(4) The Works Plan shall take into account the Bidder's proposed Design Submission Programme and should

(a) indicate, wherever possible, dates and periods relating to interfaces with and between others including dates for submission of further documents required by the Contract and periods for their acceptance.

(b) be consistent with the overall Work Plan and in accordance with the Employer's Requirements;

(c) make adequate allowance for periods of time for review by authorities whose approval is necessary;

(d) include a schedule identifying, describing, cross-referencing and explaining the Design packages and submissions which the Bidder intends to submit;

(e) take due account of the design co-ordination interface periods during which the Contractor shall be required to undertake and complete all aspects of design co-ordination with other consultants engaged in the review of the design of the Project such design will be compatible and coordinated with others and allowing adequate time for the Employer's assessments and decisions.

(5) The Work Plan shall contain sufficient detail to assure the Employer of the feasibility of the plan and approach proposed by the Bidder.

(6) The Bidder should have regard to the possibility that during the bid evaluation period the Work Plan may be developed into a Programme which, in the event of award, would be the initial submission of the Works Programme. To facilitate this process the Bidder shall, in the preparation of the Work Plan, take due account of the provisions of the Employer's Requirements in so far as they concern the Work Plan.

(7) The Work Plan shall be accompanied by a narrative statement that shall describe Programme activities, assumptions and logic, and highlight the Bidder's perception of the major constraints and critical areas of concern in the organization, construction and completion of the Works. This narrative statement shall also indicate which elements of the Works the Bidder intends to carry out off-Site and/or outside India with details of the proposed locations of where any such work is to be carried out, the facilities available and any third party undertakings the Bidder may have in this regard. In particular the Bidder must state the assumptions made in respect of the interfaces with the Employer, other contractors and third parties both in detail and time, and any requirements for information on matters which would affect his works.

(8) All programmes shall include design, procurement periods, major material, on site, offsite, off shore production/ prefabrication, temporary construction, interface and periods for System wide, utility and adjacent contractors, testing and commissioning and integrated testing along with any other training and trial running information.

(9) The proposed submission of the Work Plan and Design Submission Programme shall not, in any event, be construed as a submission under Clause 8.3 (Programme) of the General Conditions.

Explanatory Note No. 2

Reference Paragraph 2.2(4) Annexure-I - Documents for Safety, Quality and Environmental Plans

OUTLINE SAFETY PLAN

The Bidder shall submit as part of his bid an Outline Safety Plan which shall contain sufficient information to demonstrate clearly the Bidder's proposals for achieving effective and efficient safety procedures. The Outline Safety Plan should include an outline of the safety procedures and regulations to be developed and the mechanism by which they will be implemented for ensuring safety as required as per the Employer's Requirements - Construction and Sub-Clause 4.8 and 6.7 of the Conditions of Contract.

The Outline Safety Plan shall be headed with a formal statement of policy in relation to safety and shall be sufficiently informative to define the Bidder's safety plans and set out in summary an adequate basis for the development of the Site Safety Plan to be submitted in accordance with Sub-Clause 4.8 and 6.7 of the Conditions of Contract including a testing and commissioning strategy/plan for the whole of the Works.

OUTLINE QUALITY PLAN

The Bidder shall submit as part of his bid an Outline Quality Plan which shall contain sufficient information to demonstrate clearly the Bidder's proposals for achieving effective and efficient Quality Assurance and Control System. The Plan should include an outline of the procedures and regulations to be developed and the mechanism by which they will be implemented for ensuring Quality as required in terms of the Employer's Requirements. It shall also include an outline of procedures, verification and validation for all tests and materials for all the Works being done by him under this Contract.

OUTLINE ENVIRONMENTAL PLAN

The Bidder shall submit as part of his bid an Outline Environmental Plan illustrating the intended means of compliance with the requirements of Part 2 Section-VI,, Volume-1: General Specifications, to the Employer's Requirements and setting out in summary form an adequate basis for the development of the more detailed document to be submitted under Sub-Clause 4.18 of the Conditions of Contract. The Outline Environmental Plan shall contain sufficient information to demonstrate clearly the proposed method of achieving the Bidder's environmental objectives with regard to the requirement of the Contract.

The Outline Environmental Plan shall be headed with a formal statement of policy in relation to environmental protection and shall be sufficiently informative to define the Bidder's environmental plans and set out in summary an adequate basis for the submission

of a detailed and comprehensive site environmental quality management plan to be submitted in accordance with Sub-Clause 4.18 of the Conditions of Contract.

The Outline Plan shall include the methods and procedures for the Environmental Impact Assessment to be performed under the Contract.

*****

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Form LOB –FS

(Para 2.1(a), Annexure-I; Section III)

Proposal Letter – Two Stage Bidding, First Stage Technical Proposal

Date: _____

ICB No.: HQ/S&T/EC/D-B/Mughalsarai- New-Bhaupur

Invitation for Bid No.: _____

To: _____

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Dear Sir

We, the undersigned, declare that:

(a) We have examined and have no reservations to the bidding document, including Addenda issued in accordance with Instructions to Bidders (ITB)-8__;

(b) We offer to undertake the procurement of Works under the above named Contract in conformity with the bidding document.

(c) We, including any subcontractors or manufacturers for any part of the contract , have or will have nationalities from eligible countries, in accordance with ITB-4.2;

(d) We, including any subcontractors or manufacturers for any part of the contract, do not have any conflict of interest in accordance with ITB-4.3;

(e) We are not submitting more than one First Stage Technical Proposal for each Contract in this bidding process as a Bidder, either individually or as a partner in a joint venture, in accordance with ITB-4.3.

(f) We, including any of our subcontractors or manufacturers for any part of the contract, have not been declared ineligible by the Bank, under the Employer's country laws or official regulations or by an act of compliance with a decision of the United Nations Security Council;

(g) We are not a government owned entity. / We are a government owned entity but meet the requirements of ITB-4.5[1]

(h) We further undertake, if invited to do so by you, and at our own cost, to attend a clarification meeting at a place of your choice, for the purpose of reviewing our First Stage Technical Proposal and duly noting all amendments and additions thereto, and noting omissions there from that you may require.

(i) We further undertake, upon receiving your written invitation, to proceed with the preparation of our Second Stage bid, updating our First Stage Technical Proposal in accordance with the requirements from the Memorandum of the clarification meeting, and completing our Second Stage bid for performing the activities of the above noted Works, in accordance with our updated First Stage Technical Proposal, and with ITB Clause 27.

(j) We have paid, or will pay the following commissions, gratuities, or fees with respect to the bidding process or execution of the Contract:

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none")

Signature: _____

Name _____signed in the capacity of _____ duly authorized to sign the bid for and on behalf of

_____

Date: [insert day, month, year]

[1] Delete one of the two as appropriate.

Form UND

(para 2.1 (h) of Annexure-1, Section III)

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Undertaking Form

We, M/s _____ (insert name of the bidder) hereby undertake and confirm that we and our sub-contractors _____ (insert the name of sub-contractor(s)) continue meeting the criteria used at the time of prequalification.

Signature……..

Name ……Signed in the capacity of …….. duly authorized to sign the bid for and on behalf of …….

Dated dd/mm/yyyy

Form ELI 1.1

(para 2.1 (f) of Annexure-1, Section III)

Bidder Information Sheet

Date: _____
ICB No. and Title: _____
Invitation for Bid No.: _____
Contract Package Name and Number: _____
Page _____ of _____ pages

1. Bidder's Legal Name:
2. In case of JVA, legal name of each party:
3. Bidder's actual or intended Country of Registration:
4. Bidder's Year of Registration:
5. Bidder's Legal Address in Country of Registration:
6. Bidder's Authorized Representative Information Name: Address: Telephone/Fax numbers: Email Address:
7. Attached are copies of original documents of: Articles of Incorporation or Registration of firm named in 1, above, in accordance with ITB Sub-Clauses 4.1 and 4.2. In case of JVA, letter of intent to form JVA including a draft agreement, or JVA agreement, in accordance with ITB Sub-Clauses 4.1 and 11.1(i) Single Stage Bidding or 11.1(g) Two Stage Bidding. In case of government owned entity from the Employer's country, documents establishing legal and financial autonomy and compliance with the principles of commercial law, in accordance with ITB Sub-Clause 4.5.

Please note that a written authorization needs to be attached to this sheet as required by ITB 21.2 Single Stage Bidding) or ITB 17.2 Two Stage Bidding

Form ELI 1.2

(para 2.1 (g) of Annexure-1, Section III)

Party to Bidder Information Sheet

(to be completed for each member of Bidder's JV and each Specialized Subcontractor of every Bidder)

Date: _____
ICB No. and Title: _____
Invitation for Bid No.: _____
Contract Package Name and Number: _____
Page _____ of _____ pages

1. Bidder's Legal Name:
2. Bidder's Party/Specialized Subcontractor Legal name:
3. Bidder's Party/Specialized Subcontractor Country of Registration:
4. Bidder's Party/Specialized Subcontractor Year of Registration:
5. Bidder's Party/Specialized Subcontractor Legal Address in Country of Registration:
6. Bidder's Party/Specialized Subcontractor Authorized Representative Information Name: Address: Telephone/Fax numbers: Email Address:
7. Attached are copies of original documents of: Articles of Incorporation or Registration of firm named in 1, above, in accordance with ITB Sub-Clauses 4.1 and 4.2. In case of government owned entity from the Purchaser's country, documents establishing legal and financial autonomy and compliance with the principles of commercial law, in accordance with ITB Sub-Clause 4.5.

Form MOU

(para 2.1(e), Annexure 1, Section III)

Draft Memorandum of Understanding (MoU) for Joint Venture Participation

(For Bidders in India to be executed on non-judicial Stamp paper of appropriate value. For Bidders from outside India, to be executed according to the applicable laws in the Bidder's country and by taking into account the Notes shown below.)

This agreement cum memorandum of understanding is made on the ……..day of …..month……year

BETWEEN / AMONG[2]

M/s_____ having its registered office at _____ (hereinafter referred to as ……..) acting as the authorized representative of the first part,

AND

M/s_____ having its registered office at_____ (hereinafter referred to as ……) in the capacity of a Joint Member of the second/[3] other[4] part;

AND

M/s_____ having its registered office at_____ (hereinafter referred to as ……) in the capacity of a Joint Member of the third[5] part;

AND

M/s_____ having its registered office at_____ (hereinafter referred to as ……) in the capacity of a Joint Member of the fourth part.

The expressions of _____ and _____ and

[2] In case of only two members forming the Joint Venture, (i) delete the word "AMONG" else delete "BETWEEN"; and

[3] (ii) delete the words "second/" and (iii) delete the next two paragraphs.

[4] Delete the words "/other " in case of more than two members forming the Joint Venture

[5] In case of three members forming the Joint Venture delete the next paragraph.

_____and ……[6] shall wherever the context admits, mean and include their respective legal representatives & successors and permitted assigns and shall collectively be referred to as "the Parties" and individually as "the Party"

WHEREAS:
Dedicated Freight Corridor Corporation of India Limited (DFCCIL) [hereinafter referred to as "Client"] has invited bids for _____ "[Insert name of Contract Package and No.]"

NOW, THEREFORE, THE PARTIES AGREE AS FOLLOWS:

1. The following documents shall be deemed to form and be read and construed as an integral part of this MOU.
   1. Notice for Invitation for Bids, and
   2. Bidding documents as issued by Dedicated Freight Corridor Corporation of India Limited (DFCCIL)
   3. Any Addendum/Corrigendum issued by DFCCIL
   4. The bid submitted on our behalf jointly by the authorized representative.

2. The 'Parties' have studied the documents and have agreed to participate in submitting a 'bid' jointly.

3. M/s _____shall be the authorized representative of the JV for all intents and purpose and shall represent the Joint Venture in its dealing with the Client. For the purpose of submission of bid proposals, the parties agree to nominate _____ as the authorized representative duly authorized to sign and submit all documents and subsequent clarifications, if any, to the Client. However M/s_____ shall not submit any such proposals, clarifications or commitments before securing the written clearance of the other Member(s) which shall be expeditiously given by M/s_____ and M/s _____and M/s _____ to M/s_____.[7]

4. The `Parties' have resolved that the distribution of responsibilities and their proportionate share in the Joint Venture is as under:

[6] Delete the last words "and _____ and _____" in case of only two members forming the Joint Venture and delete the last words "and _____" in case of only three members forming the Joint Venture.

[7] Delete the last words "and M/s _____and M/s _____" in case of only two members forming the Joint Venture and delete the last words "M/s _____" in case of only three members forming the Joint Venture.

Joint Venture Member(s)	Financial Share (%)	Responsibilities
(i)		
(ii)		
(iii)		
(iv) [8]		

5. JOINT AND SEVERAL RESPONSIBILITY

The Parties undertake that all partners shall be jointly and severally liable to the Client in the discharge of all the obligations and liabilities in terms of the Bidding Documents issued by the Client and for the execution of contract in terms of the Contract with the Client, if awarded to the Joint Venture.

6. ASSIGNMENT AND THIRD PARTIES

The parties shall cooperate throughout the entire period of this MOU on the basis of exclusivity and none of the Parties shall make arrangement or enter into agreement either directly or indirectly with any other party or group of parties on matters relating to the Project except with prior written consent of the other party.

7. EXECUTIVE AUTHORITY

The said Joint Venture shall act through its authorized representative who shall have the authority to conduct all business for and on behalf of any and all the partners of the Joint Venture during the bidding process and, in the event the Joint Venture is awarded the Contract, during contract execution.

The management structure for the project shall be prepared by mutual consultations to enable completion of project to quality requirements of the Contract within permitted cost and time.

8. GUARANTEES

Till the award of the work, the authorized representative shall furnish bid guarantees to the Client on behalf of the Joint Venture which shall be legally binding on all the Members of the Joint Venture.

9. BID SUBMISSION

Each Party shall bear its own cost and expenses for preparation and submission of the bid and all costs until conclusion of a contract with the Client for the Project. Common expenses shall be shared by the parties in the ratio of their actual participation.

[8] Delete the last two rows in case of only two members forming the Joint Venture and delete the last row in case of only three members forming the Joint Venture.

10. INDEMNITY

Each Party hereto agrees to indemnify the other Party(ies), against its respective part in case of breach/default, of any liabilities sustained by the Joint Venture.

11. FINANCING

For the execution of the respective portions of works and to fulfil its obligations in terms of this Joint Venture Agreement, the Parties shall make their own arrangements to bring the required finance, plants and equipment, materials, manpower and other resources.

12. DOCUMENTS & CONFIDENTIALITY

Each Party shall maintain confidentiality and not use any commercial / technical information, received or generated in the course of preparation and submission of the bid or in the course of execution of the contract, if awarded to the JV, for any purpose unrelated to the Contract.

13. ARBITRATION

Any dispute, controversy or claim arising out of or relating to this agreement shall be settled, in the first instance, amicably between the Parties.

If an amicable settlement cannot be reached as above, it will be settled by arbitration in accordance with the broad principles provided for arbitration in the Conditions of Contract.

14. VALIDITY

This Agreement shall remain in force till the occurrence of the earliest to occur of the following, unless by mutual consent, the Parties agree in writing to extend the validity for a further period:

a. The bid submitted by the Joint Venture is declared unsuccessful, or
b. Cancellation/ shelving of the Project by the client for any reasons prior to award of work
c. Execution of detailed JV agreement by the parties, setting out detailed terms after award of work by the Client, substantially covering the requirements as mentioned in Section IV of bidding documents read with Sub-Clause 1.14 [Joint Several Liability] of the Conditions of Contract.

15. This MOU is drawn in _____number of copies with equal legal strength and status. One copy is held by M/s_____ and one copy by M/s _____ & M/s_____ and M/s ……., each and a copy submitted with the proposal. [9]

16. This MOU shall be construed under the laws of the Bidder's actual or intended

[9] Modify as appropriate in accordance with the number of members of the JV

country of Registration.

17. NOTICES

Notices shall be given in writing by fax confirmed by registered mail or commercial courier to the following fax numbers and addresses.

IN WITNESS WHEREOF THE PARTIES, have executed this MOU the day, month and year first before written:

Authorized Representative
Signature _____

_____
(Name, Address & Contact Details[10])

2nd Member
Signature_____

_____
(Name, Address & Contact Details)

3rd Member[11]
Signature _____

_____
(Name, Address & Contact Details)

4th Member[12]
Signature _____

_____
(Name, Address & Contact Details)

Witness

1_____ (Signature, Name & Address)

2_____ (Signature, Name & Address)

Notes:

1. *In case of existing joint venture, the certified copy of JV Agreement may be furnished.*

2. *The mode of execution should be in accordance with the procedure, if any, laid down by the applicable law in the bidder's country and the charter documents of the executants(s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.*

3. *Whenever required, the Bidder should submit for verification the extract of the charter documents and the shareholder resolution in favour of the person executing this document on behalf of the bidder.*

[10] Contact Details should contain the telephone & fax numbers and email id.
[11] Delete the 3rd and 4th member in case the JV is formed by two members only.
[12] Delete this in case the JV is formed by three members only.

4. *For a required document executed and issued overseas, the document will also have to be legalised by the Indian Embassy in the Bidder's country and notarized in the jurisdiction where it is being issued. However, documents provided by Bidders from countries that have signed the Hague Legislation Convention 1961 are not required to be legalized by the Indian Embassy, if they carry a conforming Apostle certificate.*

Form LOP

(para 2.1(d), Annexure 1, Section III)

Proforma Letter of Participation from Each Member of Joint Venture (JV)

(For Bidders in India to be executed on non-judicial Stamp paper of appropriate value. For Bidders from outside India, submission of this form is not mandatory. If an equivalent form is submitted by Bidders from outside India, it is to be executed according to the applicable law in the Bidder's country and by taking into account the Notes shown below.)

(On each Firm's Letter Head)

No._____ Date_____

From:

_____

_____

To:

The Managing Director

5th Floor, Pragati Maidan Metro Station Building

New Delhi – 110 001

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Ref: Your notice for Invitation for Bid (IFB) _____

1. We wish to confirm that our company has formed a Joint Venture with (i) ……..… and (ii) ……...…… and (iii) ……[13] for the purposes associated with IFB referred to above.

   [Member(s) who are not the authorized representative of the JV should add the following paragraph].*

   'The JV is led by ……. whom we hereby authorize to act on our behalf for the purposes of the submission of the bid for the above

[13] (i) In case the JV is formed by two members, delete the words "and (ii) ……...…… and (iii) ……"
(ii) In case the JV is formed by three members, delete the words "and (iii) ……"

mentioned work and authorize it to incur liabilities and receive instructions for and on behalf of any and all the Members or constituents of the Joint Venture.'*

OR

*(Member being the authorized representative of the group should add the following paragraph)**

'In this group we act as authorized representative and, for the purposes of applying for qualification, represent the Joint Venture' *

2. In the event of our JV is awarded the contract, we agree to be jointly with (i) _____ (ii) _____ and (iii) _____ (names of other members of our JV[14]) and severally liable to the Dedicated Freight Corridor Corporation of India Limited, its successors and assignees for all obligations, duties and responsibilities arising from or imposed by the contract subsequently entered into between Dedicated Freight Corridor Corporation of India Limited and our JV.

3. We, further agree that entire execution of the contract shall be carried out exclusively through the authorized representative.

Yours faithfully,

Company Seal

(Signature)

(Name of Signatory) _____

(Capacity of Signatory) _____

* Delete as appropriate

Notes:

1. *The mode of execution should be in accordance with the procedure, if any, laid down by the applicable law in the bidder's country and the charter documents of the executants(s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.*
2. *Whenever required, the Bidder should submit for verification the extract of the charter*

[14] (a) In case the JV is formed by two members, delete the words "and (ii) ……..…… and (iii) ……"
(b) In case the JV is formed by three members, delete the words "and (iii) ……"

documents and the shareholder resolution in favour of the person executing this document on behalf of the bidder.

3. *For a required document executed and issued overseas, the document will also have to be legalised by the Indian Embassy in the Bidder's country and notarized in the jurisdiction where it is being issued. However, documents provided by Bidders from countries that have signed the Hague Legislation Convention 1961 are not required to be legalized by the Indian Embassy, if they carry a conforming Apostle Certificate.*

Form POA -1

(para 2.1(b), Annexure 1, Section III)

Power of Attorney to submit the Bid

(For Bidders in India to be executed on non-judicial Stamp paper of appropriate value. For Bidders from outside India, submission of this form is not mandatory. If an equivalent form is submitted by Bidders from outside India, it is to be executed according to the applicable law in the Bidder's country and by taking into account the Notes shown below.)

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Know all men by these presents, we _____do hereby constitute, appoint and authorize Mr/Ms_____ who is presently employed with us and holding the position of _____as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our bid for the above mentioned work, including signing and submission of all documents and providing information/responses to Dedicated Freight Corridor Corporation of India Limited, representing us in all matters, dealing with Dedicated Freight Corridor Corporation of India Limited in all matters in connection with our bid for the said project.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall always be deemed to have been done by us.

Dated this the_____ day of _____2015

_____

(Signature and Name in Block letters of the Signatory delegating the POA)

Seal of Company

The above Power of Attorney is accepted by me

_____

(Signature and Name in Block letters of the person whom POA is being delegated)

Witness

Witness 1:	Witness 2:
Signature _____	Signature _____
Name:	Name:
Address:	Address:
Occupation:	Occupation:

Notes:

1. *The mode of execution should be in accordance with the procedure, if any, laid down by the applicable law in the bidder's country and the charter documents of the executants(s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.*

2. *Whenever required, the Bidder should submit for verification the extract of the charter documents and the shareholder resolution in favour of the person executing this document on behalf of the bidder.*
3. *For a required document executed and issued overseas, the document will also have to be legalised by the Indian Embassy in the Bidder's country and notarized in the jurisdiction where it is being issued. However, documents provided by Bidders from countries that have signed the Hague Legislation Convention 1961 are not required to be legalized by the Indian Embassy, if they carry a conforming Appostille certificate.*

Form POA -2

(para 2.1(c), Annexure 1, Section III)

Power of Attorney to the Authorized Representative of Joint Venture (JV)

(For Bidders in India to be executed on non-judicial Stamp paper of appropriate value. For Bidders from outside India, submission of this form is not mandatory. If an equivalent form is submitted by Bidders from outside India, it is to be executed according to the applicable law in the Bidder's country and by taking into account the Notes shown below.)

POWER OF ATTORNEY[15]

Whereas, Dedicated Freight Corridor Corporation of India Limited (DFCCIL) has invited bids for the work of ---------- [Insert Contract Package Name and Number], and

Whereas we, the members of the Joint Venture comprising of

(i) M/s _____; and

(ii) M/s _____; and

(iii)* M/s _____; and

(iv)* M/s_____

are interested in submission of bid for this work in accordance with the terms and conditions contained in the bidding documents and,

Whereas, it is necessary for the members of the Joint Venture to designate one of them as the authorized representative, with all necessary power and authority to do, for and on behalf of the Joint Venture, all acts, deeds and things as may be necessary in connection with the Joint Venture's bid for the project.

NOW THIS POWER OF ATTORNEY WITNESSETH THAT:

We, M/s _____and *M/s _____ and *M/s_____ hereby nominate M/s _____, being the lead member of the Joint Venture, as the authorized representative of the Joint Venture, to do on behalf of the Joint Venture, all or any of the acts, deeds or things necessary or incidental to the Joint Venture's bid for the contract, including submission of

[15] To be executed by all the members of the Joint Venture, except the lead member / authorized representative.

bid, participating in conferences, responding to queries, submission of information/documents and to represent the Joint Venture in all its dealings with the Dedicated Freight Corridor Corporation of India Limited / Railway or any other Government Agency or any person, in connection with the bid / contract for the said work until culmination of the process of bidding and till the contract agreement, if successful, is entered into with DFCCIL and thereafter till the expiry of the contract agreement.

We hereby, jointly and severally ratify, confirm and agree that all acts, deeds and things lawfully done or caused to be done by our said authorized representative or his substitute or substitutes, pursuant to this Power of Attorney, shall always be deemed to have been done by us and / or by the Joint Venture.

Dated this the_____ day of _____2015

(Signature) _____	(Signature) _____	(Signature) _____
(Name in Block letters of Executant -1)	(Name in Block letters of Executant-2)*	(Name in Block letters of Executant-3)*
Seal of Company	Seal of Company	Seal of Company

Witness 1:	Witness 2:
Signature _____	Signature _____
Name:	Name:
Address:	Address:
Occupation:	Occupation:

The above Power of Attorney is hereby accepted by me for and on behalf of the Lead Member

(Signature of the PA Holder)…….

(Name of the Power of Attorney Holder)……

(Designation)……..

For and on behalf of …….. *(Name of the Lead Member)*

Notes:

1. *The mode of execution should be in accordance with the procedure, if any, laid down by the applicable law in the bidder's country and the charter documents of the executants(s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.*

2. *Whenever required, the Bidder should submit for verification the extract of the charter documents and the shareholder resolution in favour of the person executing this document on behalf of the bidder.*

3. *For a required document executed and issued overseas, the document will also have to be legalised by the Indian Embassy in the Bidder's country and notarized in the jurisdiction where it is being issued. However, documents provided by Bidders from countries that have signed the Hague Legislation Convention 1961 are not required to be legalized by the Indian Embassy, if they carry a conforming Apostle certificate.*

* Delete as appropriate

Form CCC

(para 2.1 (j) of Annexure-1, Section III)

Current Contract Commitments / Works in Progress

Bidders and each partner to a JVA should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Name of contract	Employer, contact address/ tel/fax/email	In case of JV, Bidder's Percentage Share	Total Contract Amount	Currency ($/€/£/INR etc.)	Value of outstanding work as on 28 days before last date of submission of bids	Currency Conversion Rate as on 28 days before last date of submission of bids	Current Value of outstanding work (US$ equivalent) as on 28 days before last date of submission of bids	Estimated Completion Date	Average monthly invoicing over last six months (US$/month)	Remarks
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
1.										
2.										
3.										

Name of contract	Employer, contact address/ tel/fax/email	In case of JV, Bidder's Percentage Share	Total Contract Amount	Currency ($/€/£/INR etc.)	Value of outstanding work as on 28 days before last date of submission of bids	Currency Conversion Rate as on 28 days before last date of submission of bids	Current Value of outstanding work (US$ equivalent) as on 28 days before last date of submission of bids	Estimated Completion Date	Average monthly invoicing over last six months (US$/month)	Remarks
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
4.										
5.										
etc.										

Certified that the above information is correct as per our records and nothing has been concealed.

Signature…….Name ……Signed in the capacity of …….. duly authorized to sign the bid for and on behalf of ……. on dd/mm/yyyy

Notes:
(i) For the purpose of conversion of foreign currency into Indian Rupees (INR), Bidders shall use the Foreign Currency Reference Rates published by Reserve Bank of India on 28 days prior to last date of bid submission. In case the currency rates are not published by Reserve Bank of India, the same shall be taken from the internet web site– http://www.oanda.com/currency/historical-rates. If the rates are not available on this website also, these can be taken from the internet website http://www.xe.com/ict/

(ii) In case the Contract is in JV, the Bidder should provide amounts of complete contract in column (4), (6), (8) and (10).

Form FIN 3.3

(para 2.2 of Section III and para 2.1 (i), Annexure 1, Section III)

Financial Resources[16]

Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract or contracts, as indicated in Section III (Evaluation and Qualification Criteria).

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Source of financing	Amount (US$ equivalent)
1.	
2.	
3.	
4.	

Note: For the purpose of conversion of Indian Rupees (INR) / foreign currency into US$, Bidders shall use the Foreign Currency Reference Rates published by Reserve Bank of India on 28 days prior to last date of bid submission. In case rates of currency are not published by Reserve Bank of India, the same shall be taken from the internet web site– http://www.oanda.com/currency/historical-rates. If the rates are not available on this website also, these can be taken from the internet website http://www.xe.com/ict/

[16]In case of Joint Venture, to be submitted by each member

Form SUP

(para 2.1 (k) of Annexure-1, Section III)

Proposed Subcontractors and Suppliers for Major Items of Works

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Major Items of Materials, Equipment or Services to be subcontracted	Proposed Subcontractor, Supplier, or Service Provider	Nationality/ Location of the subcontractor, supplier or service provider	Approximate Value of proposed Subcontracting Items (in percentage of the approximate total value of the Contract)

Note:

The Bidder shall enter in this Schedule the proposed names of subcontractors, suppliers or service providers of major items of materials, equipment or services that the Bidder proposes to incorporate in the Works. Notwithstanding the provision of this information, submission of details of materials, equipment and services for approval, as required by the Contract, will be required from the Contractor.

Form CU

(para 2.1 (l) of Annexure-1, Section III)

Copyright Undertaking

The Managing Director,
Dedicated Freight Corridor Corporation,
Pragati Maidan Metro Station, New Delhi,
India 110001.

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Dear Sir,

We, (name of Bidder / Joint Venture) hereby undertake that the Design Data, Employer's Requirement, Tender Drawings etc. both in hard copy and Digitized format, and the bidding documents purchased as a necessary part of our preparation of this bid shall be used solely for the preparation of the Bid and that if the bid is successful, shall be used solely for the design of the temporary and permanent works.

We further undertake that the aforesaid tender drawings and documents prepared by Dedicated Freight Container Corporation Limited shall not be used in whole, in part or in any altered form on any other project, scheme, design or proposal that the bidder/ Joint Venture /Party to Joint Venture, Sub Contractors of the bidder or Joint Venture /parent company of Party to Joint Venture or the Bidder will be involved with either in India or in any other country.

Signature……..

Name ……Signed in the capacity of ……..

duly authorized to sign the bid for and on behalf of ……..

Dated on _____ day of _____ 2015

Form MA

Manufacturer's Authorization

(para 2.1 (m) of Annexure-1, Section III)

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Date: _____
ICB No.: _____

To: The Managing Director
Dedicated Freight Corridor Corporation of India Ltd
5th Floor, Pragati Maidan,
Metro Station Building Complex
New Delhi - 110001

WHEREAS

We (Insert name of the Manufacturer) who are official manufacturers of (Insert Name of manufacturing products) having factories at (Insert the location / address of the manufacturing facility) do hereby authorize (Insert name of the Bidder) to submit a bid for Contract No. 203: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Descriptions of Goods:

_____
_____

We hereby extend our full guarantee and warranty in accordance with Clause 11 of the General Conditions of Contract, with respect to the goods offered by the above firm.

Signed: _____

Name: _____

Title:_____

Duly authorized to sign this Authorization on behalf of: _____

Dated on _____ day of _____, _____

Form EQU

(para 2.4 of Section III)

Contractor's Equipment

The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key Contractor's equipment listed in Section III, Evaluation and Qualification Criteria.

All key equipment /plant proposed by the Bidder shall be filled in this form.

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

SN		Equipment information				Current status		Source of Equipment	Owner				Agreements*
	Item of equipment	Name of manufacturer	Model and power rating	Capacity	Country of Origin and Year of Manufacture	Current location	Details of current commitments	Owned/Rented /Leased/ Specially manufactured	Name of owner	Address of owner	Contact name and title	Telephone /Email	Details of rental/ lease/ manufacture agreements specific to the project
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**

SN		Equipment information				Current status		Source of Equipment	Owner				Agreements*
	Item of equipment	Name of manufacturer	Model and power rating	Capacity	Country of Origin and Year of Manufacture	Current location	Details of current commitments	Owned/Rented /Leased/ Specially manufactured	Name of owner	Address of owner	Contact name and title	Telephone /Email	Details of rental/ lease/ manufacture agreements specific to the project
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**

*Omit this information for equipment owned by the Bidder.

Form PER-1

(Para 2.3 of Section III)

Personnel[#]

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

S.l.	Key Position	Minimum Qualifying Requirement (years)			Proposed Personnel by the Bidder				Remarks
		Total Experience	In Similar works	Qualification	Name	Total Experience	In Similar works	Qualification	
1.	Project Director** (Signalling & Telecommunication)	20	7	B.E. (Electrical / Electronics)					
2.	Sr. Design Engineer* (Signalling)	15	5	B.E. (Electrical / Electronics)					
3.	Sr. Design Engineer*	15	5	B.E. (Electronics / Telecommunication)					

S.l.	Key Position	Minimum Qualifying Requirement (years)			Proposed Personnel by the Bidder				Remarks
		Total Experience	In Similar works	Qualification	Name	Total Experience	In Similar works	Qualification	
	(Telecommunication)								
4.	System Integrator	15	5	B.E. (Electrical / Electronics)					
5.	Interface Manager	15	7	B.E. (Civil / Electrical / Electronics / Telecommunication)					
6.	Project Manager (Signalling)	15	5	B.E. (Electrical / Electronics)					
7.	Project Manager (Telecommunication)	15	5	B.E. (Electrical / Electronics / Telecommunication)					
8.	Planner & Scheduler	15	5	B. Tech. or any other Science Graduate (should be					

S.l.	Key Position	Minimum Qualifying Requirement (years)			Proposed Personnel by the Bidder				Remarks
		Total Experience	In Similar works	Qualification	Name	Total Experience	In Similar works	Qualification	
				well conversant with Primavera or similar software)					
9.	Quality Control Expert	15	5	B.E. (Electrical / Electronics)					
10.	Systems Safety Expert	15	5	Engineering Graduate (Electrical / Electronics) with Diploma/ Specialization in Safety related field.					
11.	RAMS Expert	15	5	Engineering Graduate with Diploma/ Specialization in RAMS.					
12.	Train Management System Expert	15	5	B.E. (Electronics / Telecommunication/Electrical)					

[#]As listed in Section III.

Notes:
(i) The CV's of the Key Personnel should be enclosed as FORM PER 2
(ii) The Bidders are advised NOT to submit more than one CV against each of the above mentioned key positions. In case more than one CV is submitted for any key position, such additional CV(s) shall not be considered for evaluation purposes and only the first CV in the bidding document would be considered for evaluation.

* The Expert shall have an experience of 3 years working outside India in at least one project.

** The Expert shall have an experience of 5 years working outside India in at least two projects.

Form PER-2

(para 2.3, Section III)

Resume of Proposed Personnel

Subject: Technical Proposal for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor
Contract Package No.: 203

Name of Bidder		
Position		
Personnel information	**Name**	**Date of birth**
	Professional qualifications	
Present employment	**Name of employer**	
	Address of employer	
	Telephone	**Contact (manager / personnel officer)**
	Fax	**E-mail**
	Job title	**Years with present employer**

Summarize professional experience over the previous number of years as required wide paragraph 2.3 of **"Part 1 Bidding Procedures, Section III"**, in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

From	To	Company / Project / Position / Relevant technical and management experience

Form - LOB –SS

(para 4.1 of Section III)

Letter of Bid – Two Stage Bidding, Second Stage Bid

Date: _____

ICB No.: HQ/S&T/EC/D-B/Mughalsarai-New Bhaupur
Invitation for Bid No.: _____

To: _____

Subject: Bid for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Dear Sir,
We, the undersigned, declare that:

(a) We have examined and have no reservations to the bidding document, (including the Price Schedules 1.0, 2.0 and 2.1 to 2.3), including Addenda issued in accordance with Instructions to Bidders (ITB)-8, and we confirm that the First Stage Technical Proposal submitted originally by us shall constitute the 'Updated First Stage Technical Proposal', for the purpose of the Second Stage Bid, together with your requirements incorporated in the Memorandum of Changes (as is required pursuant to 'First Stage Technical Proposal' evaluation). We note from Addendum No.…[17] to the Bidding Documents that the Employer's Requirements have been revised.

(b) We offer to submit our bid in conformity with the bidding documents for Contract Number:……..…[*insert Contract Number*]

(c) Excluding the discounts offered below (if any), the price of our Bid for Contract No. 203 in INR is :

INR …… (Insert Bid Price in figures)

INR ……

…… (Insert Bid Price in words)

(i) The percentage breakup of Bid Price in INR and not more than 3 foreign currencies is as stated in Appendix to Bid.

[17] Insert the relevant Addenda Number(s)

(ii) Apportionment of Contract Price for Payments according to cost Centre as given in Appendix to Bid.

(iii) The Currency wise breakup of sub cost centres of the Price Schedule for Payment is given in Annexure-I of Appendix to Bid.

(d) The discounts offered and the methodology for their application are:

……

…..……..

(e) Our bid shall be valid for a period of 120 (one hundred twenty) days from the date fixed for the submission deadline for the Second Stage bids as stipulated in the Letter if Invitation to submit a Second Stage bid, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(f) If our bid is accepted, we commit to obtain a performance security, in accordance with the bidding document;

(g) We, including any subcontractors or manufacturers for any part of the contract , have or will have nationalities from eligible countries, in accordance with ITB-4.2;

(h) We, including any subcontractors or manufacturers for any part of the contract, do not have any conflict of interest in accordance with ITB-4.3;

(i) We are not submitting more than one bid for each Contract Number in this bidding process as a Bidder, either individually or as a partner in a joint venture, in accordance with ITB-4.3.

(j) We, including any of our subcontractors or manufacturers for any part of the contract, have not been declared ineligible by the Bank, under the Employer's country laws or official regulations or by an act of compliance with a decision of the United Nations Security Council;

(k) We are not a government owned entity/ We are a government owned entity but meet the requirements of ITB-4.5[18]

(l) We have paid, or will pay the following commissions, gratuities, or fees with respect to the bidding process or execution of the Contract:

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

(m) We understand that you are not bound to accept the lowest evaluated bid or any other bid that you may receive.

[18] Delete as appropriate

(n) We understand that this bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal contract is prepared and executed; and

(o) We hereby enclose Bid Security of INR 50 Million in terms of ITB 32.1 in Form BS (Section IV- Bidding Forms, Part 1)

Signature……..

Name ……Signed in the capacity of …….

duly authorized to sign the bid for and on behalf of ……

Dated on _____ day of _____.

Appendix to Bid

Subject: Bid for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

(i) The percentage break up of lump sum bid price for local and foreign currencies for Contract Package No. 203 quoted in the Letter of Bid (LOB-SS) is as follows:

Currency	**A** **Name of Currency**	**B** **Percentage of bid price**
Local currency (INR)	**INR**	
Foreign currency # 1		
Foreign currency # 2		
Foreign currency #3		

(ii) Apportionment of Contract Price for Payment, According to Cost Centre is as follows:

S. No.	**Cost Centre**	**Percentage of Contract Price**
(1)	(2)	(3)
2.1	Signalling Works	
2.2	Telecommunication Works	
2.3	Building & Structure Works	
	Total	**100%**

Note:

1. The Bidders may please note that the percentage of the Contract Price to be entered in column (3) of the table should be within the permitted range specified in column (3) “Price Schedule 2.0 Apportionment of Contract Price for Payments according to Cost Centres”
2. The total of percentages given in column (3) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) at S.N. 2.1, to 2.3 shall be adjusted prorate.

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
Signalling Works (Price Schedule 2.1)					
2.1.1	100%				
2.1.2	100%				
2.1.3	100%				
2.1.4	100%				
2.1.5	100%				
2.1.6	100%				
2.1.7	100%				
2.1.8	100%				
2.1.1.1	100%				
2.1.1.2	100%				
2.1.1.3	100%				
2.1.1.4	100%				
2.1.1.5	100%				
2.1.1.6	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.1.2.1	100%				
2.1.2.2	100%				
2.1.2.3	100%				
2.1.2.4	100%				
2.1.2.5	100%				
2.1.2.6	100%				
2.1.2.7	100%				
2.1.2.8	100%				
2.1.2.9	100%				
2.1.2.10	100%				
2.1.2.11	100%				
2.1.2.12	100%				
2.1.2.13	100%				
2.1.3.1	100%				
2.1.3.2	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.1.3.3	100%				
2.1.3.4	100%				
2.1.3.5	100%				
2.1.3.6	100%				
2.1.3.7	100%				
2.1.3.8	100%				
2.1.3.9	100%				
2.1.3.10	100%				
2.1.3.11	100%				
2.1.3.12	100%				
2.1.3.13	100%				
2.1.3.14	100%				
2.1.4.1	100%				
2.1.4.2	100%				
2.1.4.3	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.1.4.4	100%				
2.1.4.5	100%				
2.1.4.6	100%				
2.1.4.7	100%				
2.1.4.8	100%				
2.1.4.9	100%				
2.1.4.10	100%				
2.1.4.11	100%				
2.1.4.12	100%				
2.1.4.13	100%				
2.1.4.14	100%				
2.1.5.1	100%				
2.1.5.2	100%				
2.1.5.3	100%				
2.1.5.4	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.1.5.5	100%				
2.1.5.6	100%				
2.1.5.7	100%				
2.1.5.8	100%				
2.1.5.9	100%				
2.1.5.10	100%				
2.1.6.1	100%				
2.1.6.2	100%				
2.1.7.1	100%				
2.1.7.2	100%				
2.1.8.1	100%				
Telecommunication Works (Price Schedule 2.2)					
2.2.1	100%				
2.2.2	100%				
2.2.3	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.2.4	100%				
2.2.5	100%				
2.2.6	100%				
2.2.7	100%				
2.2.8	100%				
2.2.9	100%				
2.2.1.1	100%				
2.2.1.2	100%				
2.2.1.3	100%				
2.2.1.4	100%				
2.2.1.5	100%				
2.2.1.6	100%				
2.2.1.7	100%				
2.2.1.8	100%				
2.2.1.9	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.2.2.1	100%				
2.2.2.2	100%				
2.2.2.3	100%				
2.2.2.4	100%				
2.2.2.5	100%				
2.2.2.6	100%				
2.2.2.7	100%				
2.2.2.8	100%				
2.2.2.9	100%				
2.2.2.10	100%				
2.2.2.11	100%				
2.2.2.12	100%				
2.2.2.13	100%				
2.2.3.1	100%				
2.2.3.2	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.2.3.3	100%				
2.2.3.4	100%				
2.2.3.5	100%				
2.2.3.6	100%				
2.2.3.7	100%				
2.2.3.8	100%				
2.2.3.9	100%				
2.2.3.10	100%				
2.2.3.11	100%				
2.2.3.12	100%				
2.2.3.13	100%				
2.2.4.1	100%				
2.2.4.2	100%				
2.2.4.3	100%				
2.2.4.4	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.2.4.5	100%				
2.2.4.6	100%				
2.2.4.7	100%				
2.2.4.8	100%				
2.2.4.9	100%				
2.2.4.10	100%				
2.2.4.11	100%				
2.2.4.12	100%				
2.2.5.1	100%				
2.2.5.2	100%				
2.2.5.3	100%				
2.2.5.4	100%				
2.2.5.5	100%				
2.2.5.6	100%				
2.2.5.7	100%				

CURRENCY WISE BREAK-UP OF SUB COST CENTRES OF THE PRICE SCHEDULE FOR PAYMENT

Sub Cost Centre	Weightage of Cost Centre/Sub Cost Centre A=B+C+D+E	Breakup % of Column 2 for Various Currencies for Payment			
		Foreign Currency #1 (%) B	Foreign Currency #2 (%) C	Foreign Currency #3 (%) D	Local Currency (%) E
(1)	(2)	(3)	(4)	(5)	(6)
Note: *The total of percentages given in column (3) to (6) in the above table should be exactly 100%. In case the total is not 100%, the figures in column (3) to (6) shall be adjusted pro rate. Any arithmetical error in the break-up percentage of the Sub Cost-Centres of the Price Schedule shall be corrected before signing of the Agreement.*					
2.2.5.8	100%				
2.2.5.9	100%				
2.2.5.10	100%				
2.2.5.11	100%				
2.2.5.12	100%				
2.2.5.13	100%				
2.2.6.1	100%				
2.2.6.2	100%				
2.2.7.1	100%				
2.2.8.1	100%				
2.2.9.1	100%				
Building & Structure Works (Price Schedule 2.3)					
2.3.1	100%				
2.3.1.1	100%				
2.3.1.2	100%				

Form BS

(Clause 32.2; ITB; Section-I)

Form of Bid Security

Required for Second Stage Bid Only
(Bank Guarantee)
On the letterhead of the Bank

Beneficiary: Dedicated Freight Corridor Corporation of India Ltd

Invitation for Bid No: _____

Date: _____

BID GUARANTEE No.: _____

Guarantor: _____

We have been informed that _____ (hereinafter called "the Bidder") has submitted or will submit to the Beneficiary its bid (hereinafter called "the Bid") for the execution of Contract Package Name and Number _____ _____ under Invitation for Bids No. _____ ("the IFB").

Furthermore, we understand that, according to the Beneficiary's conditions, bids must be supported by a bid guarantee.

At the request of the Bidder, we ……..(*Name of the Bank*), as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (_____) *(amount in words)* upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Bidder:

(a) has withdrawn its Bid during the period of bid validity set forth in the Bidder's Letter of Bid ("the Bid Validity Period"), or any extension thereto provided by the Bidder;

or

(b) having been notified of the acceptance of its Bid by the Beneficiary during the Bid Validity Period or any extension thereto provided by the Bidder, (i) has failed to execute the contract agreement, or (ii) has failed to furnish the performance security, in accordance with the Instructions to Bidders ("ITB") of the Beneficiary's bidding document.

This guarantee will expire: (a) if the Bidder is the successful bidder, upon our receipt of copies of the contract agreement signed by the Bidder and the performance security issued to the Beneficiary in relation to such contract

agreement; or (b) if the Bidder is not the successful bidder, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Bidder of the results of the bidding process; or (ii) twenty-eight days after the end of the Bid Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758.

_____

[signature(s)] with seal of the Bank

Note: All italicized text is for use in preparing this form and shall be deleted from the final document

(Sub-clause 14.4, Conditions of Contract)

PRICE SCHEDULE 1.0

For Payments in Local & Foreign Currencies

Subject: Contract Package for Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor

Contract Package No.: 203

Bid Price for Contract Package No. 203: Design, Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and Associated Works of Double Track Railway Lines under construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor, shall be the same as the sum quoted in the Letter of Bid-Two Stage Bidding, Second Stage, in INR.

All payments in applicable currencies shall be made as per clause 14.15 of Conditions of Contract. Foreign currency requirements shall be expressed in accordance with ITB 30.1.

Component of various Items in a contract on which variation in prices be admissible, shall be Labour, Material, Fuel & Power, etc. The Labour component may be taken as 30%, Material component as 40%, Fuel & Power component as 15% and Fixed component as 15%. No price variation shall be admissible on fixed component.

For the following items to be procured from outside India the relevant indices for price adjustment shall be as stated in table below:

S No.	Item	Name of published index nearest to the Base date	SOURCE OF PUBLICATION
1	Labour Component		
2	Material		
3	Fuel & Power		

Source of Index shall be as published by Government or public organization. The bidder should also attach specimens of the publications for the last 12 months. For example, if Euro is one of the foreign currencies in which the payment of contract price is to be made, the price index should be the index published by the European Union.

Note: In case Bidder does not provide the Indexes and Sources of Index, the Bidder shall not be entitled for the Price Adjustment for the items procured from outside India.

Price Schedule 2.0 Apportionment of Contract Price for Payments According to Cost Centres

(Sub-clause 14.4, GC)

S No.	Cost Centre	Permitted Percentage Range of Contract Price
(1)	(2)	(3)
2.1	Signalling Works	70% - 80%
2.2	Telecommunication Works	20% - 30%
2.3	Building & Structure Works	2% - 3%

Bidder is permitted to propose change as per his requirement for the component of work within the range indicated in column 3 should be exactly equal to 100%. In case the total is not 100%, the figures in column (3) at S.N. 2.1 to 2.3 shall be adjusted prorate. The subsequent Price Schedules for Cost Centres/Sub-Cost Centres are fixed and the payment will be released for different cost centre/sub-cost centres as per respective weightings of the Contract price. Refer Sub-Clause 14.4 – Particular Conditions of Contract for further details.

Payments for supply of Material which is intended for installation in the Permanent Works:

1. The Contractor shall ensure that the Materials delivered at site
   a) are as per the specifications stipulated in the Contract;
   b) have met all the requirements of checks & tests; and
   c) are properly stored and protected against loss/pilferage, damage and deterioration.

2. The payment for supply of materials shall be made against an Indemnity Bond, for the amount of payment claimed, in favour of the Employer and valid till these materials are installed in the Permanent Works.

3. Supplied materials shall be deemed to be the property of the Employer, and the Contractor shall not remove these from Site of Work / Store without prior approval of the Engineer.

   Record of receipt and use of materials shall be maintained by the Contractor and made available for inspection by the Engineer/Employer as and when these may be required.

Price Schedule 2.1

Apportionment of Contract Price for

SIGNALLING WORKS

(Sub-clause 14.4, GC)

Price Schedule	No.	Cost Centre	Weightage (%)	Cost
(1)	(2)	(3)	(4)	(5)
2.1 [Signalling Works]	2.1.1	Design and Documentation	4	
	2.1.2	Signalling Works at 7 Crossing stations	8	% as in Cost Centre 2.1 of Apportionment of Contract Price.
	2.1.3	Signalling Works at 5 Junction Stations	12	
	2.1.4	Signalling Works in Automatic Block Sections	57	
	2.1.5	Train Management System (TMS)	6	
	2.1.6	Supply of Contract Spares and Special Tools & Test Equipment	8	
	2.1.7	Integrated Testing & Commissioning and Final Takeing-Over	4	
	2.1.8	Training	1	
		Total	**100 %**	

Price Schedule 2.1.1

Apportionment of Contract Price for Payment of Cost Centre

DESIGN AND DOCUMENTATION

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.1 [Design and Documentation]	Design and Documentation	2.1.1.1	Submission of Management Plans, Quality Assurance Plan, Site Safety Plan, Design Plan	10	**4 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	After Review / Approval with or without comments by the Engineer
		2.1.1.2	Submission of Preliminary Designs & Documents including RAMS	15		
		2.1.1.3	Submission of Detailed Designs & Documents	35		
		2.1.1.4	Submission of Construction /Installation Designs & Documents	10		
		2.1.1.5	Submission of As Built Documents	20		
		2.1.1.6	Submission of O & M Manuals	10		
			TOTAL	**100%**		

Note:

1. Adjustment to Contract Price pursuant to GCC 13.8 shall NOT be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

2. Payment will be made on Completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.1.2

Apportionment of Contract Price for Payment of Cost Centre

SIGNALLING WORKS AT 7 CROSSING STATIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.2 [Signalling Works At 7 Crossing Stations]	Supply of material	2.1.2.1	Supply of Signalling Cable, Power cable and Quad Cable	14	**8 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.1.2.2	Supply of EI hardware equipment along with associated software and accessories	13		
		2.1.2.3	Supply of power supply equipment and batteries along with associated accessories	3		
		2.1.2.4	Supply of track vacancy detection hardware equipment along with associated software and accessories	20		
		2.1.2.5	Supply of signals and point machines along with associated accessories	8		
		2.1.2.6	Supply of balance indoor equipment	4		
		2.1.2.7	Supply of balance outdoor equipment	3		

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	Installation	2.1.2.8	Laying, Termination & Testing of outdoor cables	3		Review and Acceptance of installation test report by the Engineer
		2.1.2.9	Installation of all indoor equipment	15		
		2.1.2.10	Installation of all outdoor equipment	6		
	Installation	2.1.2.11	Installation of Earthing and Surge Protection equipment for complete works	1		Review and Acceptance of Installation Test Report by the Engineer
	Any other item	2.1.2.12	Any other item required to be supplied, installed and tested for complete works	2		Verification/ Review/ Approval/ Acceptance by the Engineer
	System acceptance test	2.1.2.13	Supply and installation of software and system acceptance test	8		Review and Acceptance of System Acceptance Test Report by the Engineer.
			TOTAL	**100%**		

Note:

1. The boundary of Signalling Works at Crossing Station shall be from First Stop Signal to Last Stop Signal including controlling track sections in both directions**.**

2. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.

3. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.1.3

Apportionment of Contract Price for Payment of Cost Centre

SIGNALLING WORKS AT 5 JUNCTION STATIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.3 [Signalling Works at 5 Junction Stations]	Supply of material	2.1.3.1	Supply of Signalling cable, Power cable and Quad Cable	13	**12 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.1.3.2	Supply of EI hardware equipment along with associated software and accessories	12		
		2.1.3.3	Supply of power supply equipment and batteries along with associated accessories	3		
		2.1.3.4	Supply of Track Vacancy Detection hardware equipment along with associated software and accessories	22		
		2.1.3.5	Supply of Signals and Point Machines along with associated accessories	7		
		2.1.3.6	Supply of equipment for Block Proving by Axle Counter for Single line sections	3		
		2.1.3.7	Supply of balance indoor equipment	3		

Cost Centre	Item of work	Sub-Cost Centre	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
		2.1.3.8	Supply of balance outdoor equipment	2		
	Installation	2.1.3.9	Laying, Termination & Testing of outdoor cables	6		Review and Acceptance of installation test report by the Engineer
		2.1.3.10	Installation of all indoor equipment	11		
		2.1.3.11	Installation of all outdoor equipment	7		
	Installation	2.1.3.12	Installation of Earthing and Surge Protection equipment for complete works	1		Review and Acceptance of Installation Test Report by the Engineer
	Any other item	2.1.3.13	Any other item required to be supplied, installed and tested for complete works	2		Verification/ Review/ Approval/ Acceptance by the Engineer
	System acceptance	2.1.3.14	Supply and installation of software and system acceptance test	8		Review and Acceptance of System Acceptance Test Report by the Engineer.
			TOTAL	**100 %**		

Note:

1. The boundary of Signalling Works at Junction Station shall be from First Stop Signal to Last Stop Signal including controlling track sections in both directions on DFCCIL Main lines and till IR Station on single line track connecting DFCCIL and IR Stations**.**

2. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.

3. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.1.4

Apportionment of Contract Price for Payment of Cost Centre

SIGNALLING WORKS IN AUTOMATIC BLOCK SECTIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.4 [Signalling Works in Automatic Block Sections]	Supply of material	2.1.4.1	Supply of Signalling cable, Power cable and Quad Cable	15	**57 %** of the Contract Price for Price Schedule 2.1 [Signalling Works] Stage payment will be made proportionally for the track kilometers completed by the contractor.	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.1.4.2	Supply of EI hardware equipment along with associated software and accessories	16		
		2.1.4.3	Supply of power supply equipment and batteries along with associated accessories	1.5		
		2.1.4.4	Supply of track vacancy detection hardware equipment along with associated software and accessories	25		
		2.1.4.5	Supply of signals along with associated accessories	2		
		2.1.4.6	Supply of Electric Lifting Barriers & Sliding Boom along with associated accessories.	0.50		
		2.1.4.7	Supply of balance indoor equipment	3		
		2.1.4.8	Supply of balance outdoor equipment	2		
	Installation	2.1.4.9	Laying, Termination & Testing of outdoor cables	11		Review and Acceptance of installation test report by
		2.1.4.10	Installation of all indoor equipment	5		

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		2.1.4.11	Installation of all outdoor equipment	8		the Engineer
	Installation	2.1.4.12	Installation of Earthing and Surge Protection equipment for complete works	1		Review and Acceptance of Installation Test Report by the Engineer
	Any other item	2.1.4.13	Any other item required to be supplied, installed and tested for complete works	2		Verification/ Review/ Approval/ Acceptance by the Engineer
	System acceptance test	2.1.4.14	Supply and installation of software and system acceptance test	8		Review and Acceptance of System Acceptance Test Report by the Engineer.
			TOTAL	100%		

Note:

1. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.1.5

Apportionment of Contract Price for Payment of Cost Centre

TRAIN MANAGEMENT SYSTEM (TMS)

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.5 [Train Management System (TMS)]	Supply of material	2.1.5.1	Supply of TMS hardware equipment along with associated Cables, associated software & accessories for OCC	25	**6 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.1.5.2	Supply of TMS hardware equipment along with associated Cables, associated software & accessories for locations other than OCC.	10		
		2.1.5.3	Supply of power supply equipment and batteries along with associated accessories for OCC.	4		
		2.1.5.4	Supply of video wall display system along with associated software and accessories for OCC	20		
		2.1.5.5	Supply of balance equipment for TMS.	6		
	Installation	2.1.5.6	Installation of all indoor equipment including video display units	12		Review and Acceptance of
		2.1.5.7	Installation of all equipment at locations outside OCC	10		

Cost Centre	Item of work	Sub-Cost Centre	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
		2.1.5.8	Installation of Earthing and Surge Protection equipment for complete works	2		Installation Test Report by the Engineer
	Any other item	2.1.5.9	Any other item required to be supplied, installed and tested for complete works	1		Verification/ Review/ Approval/ Acceptance by the Engineer
	System acceptance test	2.1.5.10	System acceptance test	10		Review and Acceptance of System Acceptance Test Report by the Engineer
			TOTAL	**100 %**		

Note:

1. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.1.6

Apportionment of Contract Price for Payment of Cost Centre

SUPPLY OF CONTRACT SPARES AND SPECIAL TOOLS & TEST EQUIPMENT

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.1.6 [Supply of Contract Spares and Special Tools & Test equipment]	Contract Spares	2.1.6.1	Supply of Contract Spares along with all other associated accessories	80	**8 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	On Supply of 'Contract Spares, Special Tools & Test Equipment to the Employer as per approved list duly inspected by the appropriate authority and approved by the Engineer
	Special Tools & Test equipment	2.1.6.2	Supply of Special Tools & Test equipment	20		
			TOTAL	100%		

Note:

1. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.1.7

Apportionment of Contract Price for Payment of Cost Centre

INTEGRATED TESTING & COMMISSIONING AND FINAL TAKING-OVER

(Sub-clause 14.4, GC)

Cost Centre	**Item of work**	**Sub-Cost Centre**	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	**Weightage (%)**	**Cost**	**Payment Procedure**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
2.1.7 [Integrated Testing & Commissioning and Final Taking-Over]	Integrated Testing & Commissioning and Final Taking-Over	2.1.7.1	Successful Completion of Integrated Testing & Commissioning	50	**4 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	Review and Acceptance of Integrated Testing & Commissioning reports by the Engineer
		2.1.7.2	Final Taking-Over Certificate for the complete work	50		Issue of Taking over Certificate by the Engineer
			TOTAL	**100%**		

Note:

1**.** Adjustment to Contract Price pursuant to GCC 13.8 shall not be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.1.8

Apportionment of Contract Price for Payment of Cost Centre

TRAINING

(Sub-clause 14.4, GC)

Cost Centre	**Item of work**	**Sub-Cost Centre**	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	**Weightage (%)**	**Cost**	**Payment Procedure**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
2.1.8 [Training]	Training	2.1.8.1	Training	100	**1 %** of the Contract Price for Price Schedule 2.1 [Signalling Works]	On completion of Training as per approved Training Plan and submission of Training Manuals duly reviewed and/or approved by the Engineer
			TOTAL	100%		

Note:

1. Adjustment to Contract Price pursuant to GCC 13.8 shall not be applicable to the payments of Works executed under this Cost Centre / Price Schedule.
2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.2

Apportionment of Contract Price for

TELECOMMUNICATION WORKS

(Sub-clause 14.4, GC)

Price Schedule	No.	Cost Centre	Weightage (%)	Cost
(1)	**(2)**	**(3)**	**(4)**	**(5)**
2.2 [Telecommunication Works]	2.2.1	Design and Documentation	5	**% as in Cost Centre 2.2 of Apportionment of Contract Price**
	2.2.2	Telecom Works at 7 Crossing stations	15	
	2.2.3	Telecom Works at 5 Junction stations	12	
	2.2.4	Telecom works at Operational Control Centre (OCC)	5	
	2.2.5	Telecom works in Automatic Block Sections & Single Line Sections	46	
	2.2.6	Integrated Testing & Commissioning and Final Taking-Over	5	
	2.2.7	Contract Spares	6	
	2.2.8	Special Tools & Test Equipment	4	
	2.2.9	Training	2	
		Total	**100%**	

Price Schedule 2.2.1

Apportionment of Contract Price for Payment of Cost Centre

DESIGN AND DOCUMANTATION

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.1 [Design and Documentation]	Management Plan	2.2.1.1	Project Management Plan, Quality Management Plan, Quality Assurance Plan, Site Safety Plan, Design Plan	**10**	**5 %** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	After review / approval with or without comments by the Engineer
		2.2.1.2	Reliability Plan, Maintainability Plan, Interface Management Plan, EMC Management Plan, Procurement, Manufacturing & Supply Plan, Software Support Plan, Factory Acceptance Testing Plan, Construction and Installation Management Plan, On-site Testing & Commissioning Plan	**10**		
		2.2.1.3	Operation & Maintenance Plan, Training Plan, Spare Parts & Consumable Management Plan, Defect Liability Management Plan, Maintenance Manpower Plan, Trial Run Plan	**5**		
	Design Documents	2.2.1.4	All Preliminary Design Documents including RAMS Documents	**10**		
		2.2.1.5	All Detailed Design Documents including EMC	**15**		

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Documents & Interface Specification for complete works.			
		2.2.1.6	All Installation Design Documents for Complete Works	**10**		
	O&M Manuals	2.2.1.7	O&M Manual for Completed Works	**15**		
	As-Built Drawings	2.2.1.8	As-Built Drawings for Completed Works	**20**		
	Any other document	2.2.1.9	Balance documents required to be given as part of the Contract	**5**		
			TOTAL	100%		

Note:

1. Adjustment to Contract Price pursuant to GCC 13.8 shall not be applicable to the payments of Works executed under this Cost Centre / Price Schedule.
2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.2.2

Apportionment of Contract Price for Payment of Cost Centre

TELECOM WORKS AT 7 CROSSING STATIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.2 [Telecom Works at 7 Crossing stations]	Supply of material	2.2.2.1	Supply of PIJF Telephone Cables	**10**	**15 %** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.2.2.2	Supply of OFC System Hardware along with associated software & accessories.	**20**		
		2.2.2.3	Supply of Data Networking System Hardware along with associated software & accessories.	**10**		
		2.2.2.4	Supply of Telephone System Hardware along with associated software & accessories	**15**		
		2.2.2.5	Supply of Master Clock System Hardware along with associated software & accessories.	**2**		
		2.2.2.6	Supply of VHF communication System Hardware along with associated software & accessories.	**4**		
		2.2.2.7	Supply of 48 V DC Battery Backup System Hardware along with associated software & accessories.	**10**		

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		2.2.2.8	Supply of balance Indoor and Outdoor equipment.	**4**		
	Installation	2.2.2.9	Installation of all Indoor equipment	**5**		Review and Acceptance of Installation Test Report by the Engineer
		2.2.2.10	Installation of all Outdoor equipment	**5**		
		2.2.2.11	Laying, Termination & Testing of Outdoor Telecom Cables	**5**		
		2.2.2.12	Installation of Earthing and Surge Protection equipment	**5**		
	System Acceptance Test	2.2.2.13	Supply and installation of software and System Acceptance Test	**5**		Review and Acceptance of System Acceptance Test Report by the Engineer
			TOTAL	**100%**		

Note:

1. Telecom Works at Crossing Stations shall also include Telecom works up to and at nearest IMD, IMSD and Residential Colonies.

2. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.

3. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.3

Apportionment of Contract Price for Payment of Cost Centre

TELECOM WORKS AT 5 JUNCTION STATIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.3 [Telecom Works at 5 Junction stations]	Supply of material	2.2.3.1	Supply of PIJF Telephone Cables	**10**	**12%** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.2.3.2	Supply of OFC System Hardware along with associated software & accessories.	**20**		
		2.2.3.3	Supply of Data Networking System Hardware along with associated software & accessories.	**10**		
		2.2.3.4	Supply of Telephone System Hardware along with associated software & accessories	**15**		
		2.2.3.5	Supply of Master Clock System Hardware along with associated software & accessories.	**2**		
		2.2.3.6	Supply of VHF communication System Hardware along with associated software & accessories.	**4**		
		2.2.3.7	Supply of 48 V DC Battery Backup System Hardware along with associated software & accessories.	**10**		

Cost Centre	Item of work	Sub-Cost Centre	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
		2.2.3.8	Supply of balance Indoor and Outdoor equipment.	**4**		
	Installation	2.2.3.9	Installation of all indoor equipment	**5**		Review and Acceptance of Installation Test Report by the Engineer
		2.2.3.10	Installation of all outdoor equipment	**5**		
		2.2.3.11	Laying, Termination & Testing of Outdoor Telecom Cables	**5**		
		2.2.3.12	Installation of Earthing and Surge Protection equipment	**5**		
	System acceptance test	2.2.3.13	Supply and installation of software and System Acceptance Test	**5**		Review and Acceptance of System Acceptance Test Report by the Engineer
			TOTAL	100%		

Note:

1. Telecom Works at Junction Stations shall also include Telecom works up to and at nearest IMD, IMSD and Residential Colonies.

2. Telecom Works at Junction shall also include Telecom Works up to and at nearest IR Station.

3. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.

4. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.4

Apportionment of Contract Price for Payment of Cost Centre

TELECOM WORKS AT OPERATIONAL CONTROL CENTRE (OCC)

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.4 [Telecom works at Operational Control Centre (OCC)]	Supply of material	2.2.4.1	Supply of PIJF Telephone Cables	5	**5 %** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.2.4.2	Supply of OFC System Hardware along with associated software & accessories.	**15**		
		2.2.4.3	Supply of Data Networking System Hardware along with associated software & accessories.	**15**		
		2.2.4.4	Supply of Telephone System Hardware along with associated software & accessories.	**10**		
		2.2.4.5	Supply of Master Clock System Hardware along with associated software & accessories.	**4**		
		2.2.4.6	Supply of 48V DC Battery Backup System Hardware along with associated	**6**		

Cost Centre	Item of work	Sub-Cost Centre	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
			accessories.			
		2.2.4.7	Supply of MTRC System Hardware along with associated accessories	**8**		
		2.2.4.8	Supply of balance Indoor and Outdoor equipment	**5**		
	Installation	2.2.4.9	Installation of all indoor equipment	**10**		Review and Acceptance of Installation Test Report by the Engineer
		2.2.4.10	Installation of all outdoor equipment	**8**		
	Installation	2.2.4.11	Installation of Earthing and Surge Protection equipment	**4**		Review and Acceptance of Installation Test Report by the Engineer
	System acceptance test	2.2.4.12	Supply and installation of software and System Acceptance Test	**10**		Review and Acceptance of System Acceptance Test Report by the Engineer
			TOTAL	100%		

Note:

1. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.5

Apportionment of Contract Price for Payment of Cost Centre

TELECOM WORKS IN AUTOMATIC BLOCK SECTIONS & SINGLE LINE SECTIONS

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.5 [Telecom works in Automatic Block Sections & Single Line Sections]	Supply of material	2.2.5.1	Supply of Optic Fibre Cables	**20**	**46%** of the Contract Price for Price Schedule 2.2 [Telecommunication Works] Stage payment will be made proportionally for the track kilometers completed by the contractor	On supply of material at site as per approved quantity duly inspected by the appropriate authority and verified by the Engineer
		2.2.5.2	'Supply of OFC System Hardware along with associated software & accessories	**10**		
		2.2.5.3	Supply of Cab Radio complete with power supply, battery pack, antenna, software & accessories	**3**		
		2.2.5.4	Supply of OPH & GPH complete with accessories, battery pack and carry case and 100% spare batteries	**2**		
		2.2.5.5	Supply of Radio Towers complete with antenna, cables, aviation lighting, Earthing etc.	10		
		2.2.5.6	Supply of BSS System Hardware along with associated accessories	**15**		

Cost Centre	Item of work	Sub-Cost Centre	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
			for MTRC			
		2.2.5.7	Supply of 48 V DC Battery Backup System Hardware along with associated accessories.	**7**		
		2.2.5.8	Supply of balance indoor & outdoor equipment	**3**		
	Installation	2.2.5.9	Installation of all indoor equipment	**5**		Review and Acceptance of Installation Test Report by the Engineer
		2.2.5.10	Installation of all outdoor equipment	**5**		
		2.2.5.11	Laying, Termination & Testing of Outdoor Telecom Cables	**10**		
	Installation	2.2.5.12	Installation of Earthing and Surge Protection equipment	**5**		Review and Acceptance of Installation Test Report by the Engineer
	System acceptance test	2.2.5.13	System Acceptance Test	**5**		Review and Acceptance of System Acceptance Test Report by the Engineer
			TOTAL	100%		

Note: 1. Telecom Works in Automatic Block Sections shall cover all Telecom Works between two adjacent Crossing Stations/ Junction Stations and shall also include Telecom Works at TSS, SP, SSP and other Buildings.

2. Payment will be made on Prorata completion of each Payment Stage as per weightage given in this schedule.
3. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.6

Apportionment of Contract Price for Payment of Cost Centre

INTEGRATED TESTING & COMMISSIONING AND FINAL TAKING-OVER

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.6 [Integrated Testing & Commissioning and Final Taking-Over]	Integrated Testing & Commissioning and Final Taking-Over	2.2.6.1	Successful Completion of Integrated Testing & Commissioning	**50**	**5 %** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	Review and Acceptance of Integrated Testing & Commissioning Report by the Engineer
		2.2.6.2	Final Taking-Over Certificate for the complete work	**50**		Issue of Taking over Certificate by the Engineer
			TOTAL	100%		

Note:

1. Adjustment to Contract Price pursuant to GCC 13.8 shall NOT be applicable to the payments of Works executed under this Cost Centre / Price Schedule.
2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.2.7

Apportionment of Contract Price for Payment of Cost Centre

CONTRACT SPARES

(Sub-clause 14.4, GC)

Cost Centre	**Item of work**	**Sub-Cost Centre**	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	**Weightage (%)**	**Cost**	**Payment Procedure**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
2.2.7 [Contract Spares]	Contract Spares	2.2.7.1	Supply of Contract Spares along with all other associated accessories	**100**	**6%** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On Supply of Contract Spares to the Employer as per approved list duly inspected by the appropriate authority and approved by the Engineer
			TOTAL	100%		

Note:

1. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.8

Apportionment of Contract Price for Payment of Cost Centre

SPECIAL TOOLS & TEST EQUIPMENT

(Sub-clause 14.4, GC)

Cost Centre	Item of work	Sub-Cost Centre	Stage Payment (Stage to be completed to qualify for Payment of Sub-Cost Centre)	Weightage (%)	Cost	Payment Procedure
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.2.8 [Special Tools & Test Equipment]	Special Tools and Test Equipment	2.2.8.1	Supply of Special Tools and Test Equipment along with all other associated accessories, Operation and Maintenance Manual and Calibration Certificate	**100**	**4 %** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On supply of Special Tools & Test Equipment to the Employer as per approved list duly inspected by the appropriate authority and approved by the Engineer
			TOTAL	100%		

Note:

1. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.
2. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

Price Schedule 2.2.9

Apportionment of Contract Price for Payment of Cost Centre

TRAINING

(Sub-clause 14.4, GC)

Cost Centre	**Item of work**	**Sub-Cost Centre**	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	**Weightage (%)**	**Cost**	**Payment Procedure**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
2.2.9 [Training]	Training	2.2.9.1	Training	**100**	**2%** of the Contract Price for Price Schedule 2.2 [Telecommunication Works]	On completion of Training as per approved Training Plan and submission of Training Manuals duly reviewed and/or approved by the Engineer
			TOTAL	100%		

Note:

1. Adjustment to Contract Price pursuant to GCC 13.8 shall NOT be applicable to the payments of Works executed under this Cost Centre / Price Schedule.
2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Price Schedule 2.3

Apportionment of Contract Price for

BUILDING & STRUCTURE WORKS

(Sub-clause 14.4, GC)

Price Schedule	No.	Cost Centre	Weightage (%)	Cost
(1)	**(2)**	**(3)**	**(4)**	**(5)**
2.3 [Buildings and Structures Works]	2.3.1	Building & Structure Works	**100**	% as in Cost Centre 2.3 of Apportionment of Contract Price.
		Total	**100%**	

Price Schedule 2.3.1

Apportionment of Contract Price for Payment of Cost Centre

BUILDING & STRUCTURE WORKS

(Sub-clause 14.4, GC)

Cost Centre	**Item of work**	**Sub-Cost Centre**	**Stage Payment** (Stage to be completed to qualify for Payment of Sub-Cost Centre)	**Weightage (%)**	**Cost**	**Payment Procedure**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
2.3.1 [Buildings and Structures Works]	Buildings and Structures Works	2.3.1.1	Completion of all civil works for the Building & Structure works	**80**	**1%** of the Contract Price for Price Schedule 2.3 [the payment will be made proportionally for total number of buildings and structures]	Acceptance of the civil works by the Engineer
		2.3.1.2	Completion of all other works	**20**		Issue of completion certificate for the Buildings and Structures by the Engineer
			TOTAL	100%		

Note: 1. Adjustment to Contract Price pursuant to GCC 13.8 shall be applicable to the payments of Works executed under this Cost Centre / Price Schedule.

2. Payment will be made on completion of each Payment Stage as per weightage given in this schedule.

Section V. Eligible Countries

Eligibility for the Provision of Goods, Works and Services in Bank-Financed Procurement

1. In accordance with Para 1.8 of the Guidelines: Procurement under IBRD Loans and IDA Credits, dated January 2011, the Bank permits firms and individuals from all countries to offer goods, works and services for Bank-financed projects. As an exception, firms of a Country or goods manufactured in a Country may be excluded if:

   Para 1.8 (a) (i): as a matter of law or official regulation, the Borrower's Country prohibits commercial relations with that Country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of the Goods or Works required, or

   Para 1.8 (a) (ii): by an Act of Compliance with a Decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's Country prohibits any import of goods from that Country or any payments to persons or entities in that Country.

2. For the information of borrowers and bidders, at the present time firms, goods and services from the following countries are excluded from this bidding:

   (a) With reference to paragraph 1.8 (a) (i) of the Guidelines: None

   (b) With reference to paragraph 1.8 (a) (ii) of the Guidelines: None

डेडीकेटेड फ्रेट कोरीडोर

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: CP-203

Issued on: **30-03-2015**

ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

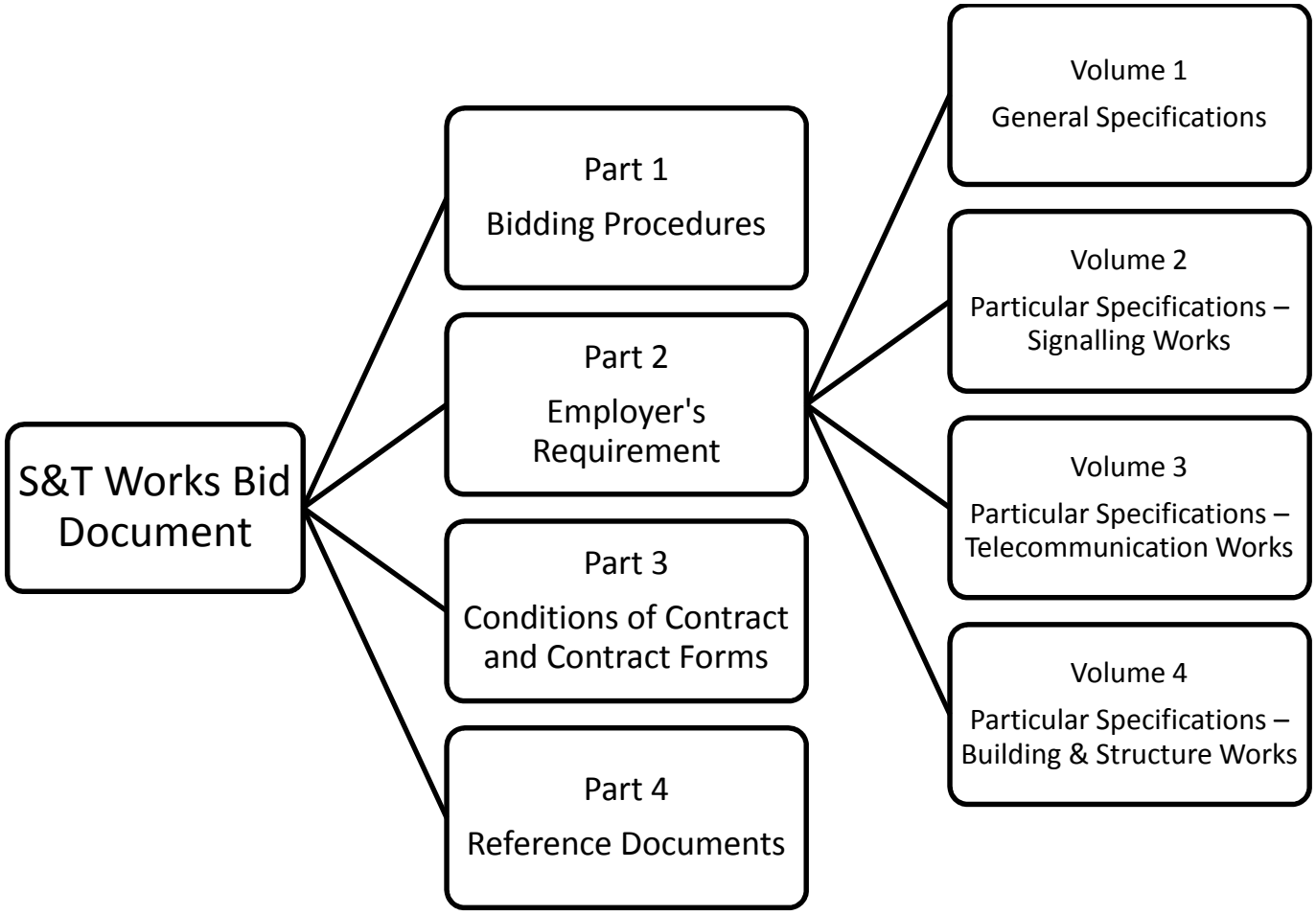
Part 2, Section VI, Volume 1,

General Specifications

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)

COUNTRY: **INDIA**

30.03.2015


S&T Works Bid Document
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Employer's Requirement
Part 3
Conditions of Contract and Contract Forms
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CHAPTER 1 –INTRODUCTION AND SCOPE

1.1 Introduction

1.1.1 Dedicated Freight Corridor Corporation of India Ltd. (DFCCIL), a public sector undertaking, has been set up under the Indian Companies Act 1956 for implementation of Dedicated Freight Corridor Project. Government of India is the sole shareholder of the DFCCIL. DFCCIL has planned to construct a Dedicated Freight Corridor (DFC) covering about 3363 route kilometers on Eastern and Western Corridors. The coverage of Eastern Corridor is from Ludhiana to Dankuni and that of Western Corridor (WDFC) from Jawaharlal Nehru Port, Mumbai to Dadri near Delhi. There will be a linkage between two corridors at Dadri.

1.1.2 Eastern DFC Route will be approximately 1847 km long from Dankuni to Sahnewal (Ludhiana) via Dankuni–Asansol–Dhanbad–Gaya–Sonnagar–Mughalsarai–Allahabad-Kanpur–Tundla–Aligarh-Khurja-Hapur–Meerut–Saharanpur–Ambala–Sahnewal.

1.1.3 EDFC Phase-1 covers the construction of Double Line Electrified Section of approximately 343 route km length between New Bhaupur and New Khurja.

EDFC Phase-2 covers the construction of Electrified Section covering a route length of approximately 388.14 Km (Double Line) between Mughalsarai and New Bhaupur; and approximately 29.15 Km (Single Line) between Junction Stations and IR Stations. Bulk of the length between Mughalsarai and New Bhaupur runs parallel and close to the existing IR network. However, detours have been planned at eight locations. This section has 5 Junction Stations and 7 Crossing Stations. These Junction Stations are connected with the stations of IR for entry/exit of the trains to IR from DFC through Single Line Electrified Sections covering a route length of approximately 29.15 route km.

EDFC Phase-3 involves construction of Single Line Electrified Section of about 404 route km between Khurja-Meerut Saharanpur-Ambala-Sahnewal (near Ludhiana) and about 46 km of Double Line Electrified Section connecting Khurja and Dadri; where it links with Western Corridor of DFC.

The section between Mughalsarai-Sahnewal (1183 RKM) is being financed by the World Bank.

1.1.4 The section between Mughalsarai-Sonnagar (122 RKM) is Double Line Electrified Section under construction by direct funding from Ministry of Railways.

1.1.5 The section between Sonnagar-Dankuni (534 RKM) will be implemented through Public Private Partnership (PPP).

1.1.6 The bridges and formation will be designed for 32.5T axle load while the track structure will be designed for 25T axle load operating at train speed of up to 100 kmph.

1.1.7 The Eastern Corridor will handle single stack containers whereas Western Corridor is planned to cater to double stack containers.

1.1.8 Upgradation of transportation technology, increase in productivity and reduction in unit transportation costs have been taken as guiding principles for formulating the project. Various operating systems, motive powers, signalling and work processes are required to conform to these broad perspectives.

1.2 Project Information of EDFC Phase-2

1.2.1 EDFC Phase-2 covers the construction of Double Line Electrified Section covering a route length of approximately 388.14 km between Mughalsarai and New Bhaupur and Single Line Electrified Sections covering a route length of approximately 29.15 km between Junction Stations and IR stations. The details are as below

(1) The Double Line Section covers a route length of approximately 388.14 km between Mughalsarai and New Bhaupur. Bulk of the length between Mughalsarai and New Bhaupur runs parallel and close to the existing IR network. However, detours have been planned at eight locations. The details of this Double Line Section are as follows:

Section	Existing Railway Km/(DFC Chainage)		Approx. Total Route Length	Remarks
	From	To		
Mughalsarai to New Karchana	Km-669.670/ (Ch-119.550)	Km- /(Ch-278.155)	158.605 (DL)	Parallel Length (DL)–121.985 km Detour Length (DL) – 36.620 km
New Karchana to New Bhaupur (excluding)	Km– /(Ch.278.155)	Km– /(Ch-507.693)	229.538 (DL)	Parallel Length (DL)–139.889 km Detour Length (DL) – 89.649 km

(2) The Junction Stations of EDFC Phase-2 are connected through Single Line Sections with the Stations of Indian Railways for entry/exit of the trains from/to Indian Railways. The details of these Single Line Sections are as follows:

DFCC Junction Station – IR station	Approximate Route km
Mughalsarai(EDFC)–Mughalsarai(IR)	Parallel to IR Yard
New Ahraura Road–Jeonathpur(IR)	8.73 km
New Karchana–Cheoki(IR)	4.8 km
New Karchana–Iradatganj(IR)	8.9 km
New Kanpur–Rooma(IR)	4.04 km
New Bhimsen–Bhimsen(IR)	2.68 km

1.2.2 The salient features of the Track Structure and Formation on Mughalsarai-New Bhaupur Section of Eastern Dedicated Freight Corridor are as follows:

SN	Description	Details & Particular
1.	Gauge	1676millimeters
2.	Main Line, Loops and Sidings	60 kg/M Rail, 1 in 12 curved thick web switches with CMS Crossings on Fan shaped PSC Sleepers layout
3.	Sleepers	PSC Mono-Block, 60 kg/M
4.	Formation Width	

SN	Description	Details & Particular
	a) Embankment (Straight Track) b) Cuttings(Straight Track) excluding side drains	For Double line : 13500 mm minimum For Single line : 7600 mm For Double line : 13500 mm minimum For Single line : 7500 mm
5.	Radii of curves	Shall generally be not less than 700meters on main lines (2.5 degrees)
6.	Maximum gradient	1:200 compensated
7.	Slope Gradient for Ballast Section	As per RDSO GE: 0014
8.	Cross Slope on top of formation	1 in 30
9.	Formation	As per guidelines and specifications for design formation for Heavy (32.5 T) Axle Load stipulated by GE: 0014
10.	Ballast Cushion a) Main Line b) Loop Line and sidings	 350 millimeters 250 millimeters
11.	Bridges	32.5 T Axle Load DFC Loading

1.2.3 The list of Junction & Crossing Stations along with their chainages in EDFC Phase-2 are detailed as below:

(1) **Junction Stations**

Junction Stations are the interchange stations with Indian Railways. These Junction Stations with their respective chainages (indicative) for Mughalsarai-New Bhaupur section are as detailed below:

SN	Name of Station	Chainage of Centre Line of the Station
1.	Mughalsarai	Km 124.626
2.	New Ahraura Road	Km 138.675
3.	New Karchana	Km 269.155
4.	New Kanpur	Km 461.369
5.	New Bhimsen	Km 486.349

(2) **Crossing Stations**

The list of Crossing stations with their respective chainages (Indicative) for Mughalsarai-New Bhaupur section are as detailed below:

SN	Name of Station	Chainage of Center Line of the Station
1.	New Dagmagpur	Km 162.700
2.	New Mirjapur	Km 192.700
3.	New Unchdih	Km 234.900
4.	New Manauri	Km 296.155

SN	Name of Station	Chainage of Center Line of the Station
5.	New Sujatpur	Km 334.144
6.	New Rasulabad	Km 378.558
7.	New Malwan	Km 423.062

1.2.4 **Level Crossings Gates**

There are 75 level crossing gates in Mughalsarai-New Bhaupur Section, i.e. in EDFC Phase-2, which will be replaced by ROB/RUB in a phased manner. It is anticipated that on 18 LC Gates, the work of ROB/RUB is not likely to be completed before the commissioning of Freight Corridor in the Section. Therefore these 18 LC Gates will be required to be interlocked with Gate Signals. New Gate Lodges will also be built on all the 18 LC Gates to be interlocked. The details of these Level Crossings are placed at Annexure-1.

1.2.5 **Maintenance Depots**

The Integrated Maintenance Depots (IMDs) and Integrated Maintenance Sub Depots (IMSDs) as indicated below have been planned in EDFC Phase-2. These depots will have maintenance facilities for assets Electrical, Civil, Signal & Telecommunication. The locations of these Integrated Maintenance Depots (IMDs) and Integrated Maintenance Sub- Depots (IMSD) is given below:

SN	Place of IMD	Place of IMSD
1	Mughalsarai,	New Dagmagpur
2	New Karchana	New Unchdih
3	New Kanpur	New Manauri
4	--	New Rasulabad
5	--	New Malwan

1.2.6 DFCC has planned residential complexes for its staff. A total no. of 263 Residential Quarter/Houses, 1 Guest House and 1 Club/Institute shall be constructed in EDFC Phase-2.

1.2.7 **Operation Control Center Facilities**

Centralized Operational Control Centre (OCC) for the entire Eastern Dedicated Freight Corridor, i.e. including EDFC Phase-2, is being constructed at Allahabad under a separate Contract Package CP-104. The OCC shall house the Train Management System and Traction Power SCADA for entire EDFC. All the controllers such as Traffic Controllers, Track Controller, Traction Power Controllers, and Signal Fault Controller etc. shall monitor and manage all train operations and associated activities, including maintenance of entire EDFC from the OCC.

1.2.8 **Electrical System**

1.2.8.1 The entire section of EDFC Phase-2 shall be provided with 25 kV AC, 50 Hz, AT Feeding, Electric Traction Power System. This Electric Traction Power System shall also include Traction Sub-station (TSS), Sectioning Post (SP) and Sub-sectioning Post (SSP).The Employer has acquired land for TSSs, SPs and SSPs at locations as given in Annexure-2. These locations of TSSs, SPs and SSPs are tentative and may change during execution of work for EDFC Phase-2.

1.2.8.2 Control and Monitoring of Traction Power System shall be via a dedicated Supervisory Control and Data Acquisition (SCADA) System.

1.3 Contract Packages for EDFC Phase-2

1.3.1 The work of EDFC Phase 2 has been divided in different contract packages as under:

Contract Package No.	Jurisdiction	Description
CP-201	Mughalsarai to New Karchana	Civil, Structure and Track
CP-202	New Karchana to New Bhaupur (excluding)	Civil, Structure and Track
CP-203	Mughalsarai to New Bhaupur (excluding)	Signalling and Telecommunication
CP-204	Mughalsarai to New Bhaupur (excluding)	Electric Traction Power System and E&M Works

1.3.2 Main Line Route covered under Civil, Structure and Track (CST) Contract Packages(CP-201 and CP-202) are as below:

Contract Package	Existing Railway Km/(DFC Chainage)		Approx. Total Route Length	Remarks
	From	To		
CP-201	Km-669.670/ (Ch-119.550)	Km- /(Ch-278.155)	158.605 (DL) 22.430 (SL)	Parallel Length (DL)–121.985 km Detour Length (DL) – 36.620 km Link Line Length(SL)-22.430 Km
CP-202	Km– /(Ch.278.155)	Km– /(Ch-507.693)	229.538 (DL) 6.720(Km)	Parallel Length (DL) – 139.889 km Detour Length (DL) – 89.649 km Link Line Length(SL)-6.720 Km

1.3.3 The Building and Structure works of Station Buildings, Level Crossing Gate Lodges, IMDs, IMSDs, Residential Buildings, Club/Institute and Guest House are covered in Civil, Structure and Track (CST) Contract Packages (CP-201 and CP-202).

1.3.4 The work of 25 kV AC, 50 Hz, AT Feeding, Electric Traction Power System is covered under Contract Package CP-204. Control and Monitoring of Traction Power System shall be via a dedicated Supervisory Control and Data Acquisition (SCADA) System and is also covered under Contract Package CP-204.

1.3.5 The Building and Structure works of Traction Sub-station (TSS), Sectioning Post (SP) and Sub-sectioning Post (SSP) is covered under Contract Package CP-204.

1.3.6 The work under scope of Contract Package CP-204 shall also include electrification of all Residential and Service Buildings of EDFC Phase-2(including S&T Service Buildings to be built under Contract Package CP-203).

1.3.7 The provision of Mains Power Supply(from Local Supply, Up & Dn AT Supply & DG Sets) for Signalling & Telecommunication Systems at Stations, Level Crossing Gates, Auto Location Huts, GSM-R Locations, IMDs/IMSDs and Residential Complexes is covered Contract Package CP-204.

1.3.8 The Building & Structure and Electrical work of Centralized Operational Control Centre (OCC) for the entire Eastern Dedicated Freight Corridor, i.e. including EDFC Phase-2, being constructed at Allahabad is covered under Contract Package CP-104.

1.3.9 The Backup Control Centre (BCC) is to be constructed in future at NOIDA. The work of BCC is not included in the scope of work Contract Packages of EDFC Phase-2(CP-201, CP-202, CP-203 & CP-204).

1.3.10 Civil, Structure and Track (CST) Contract Packages (CP-201 and CP-202) are planned to commence about a year ahead of Signalling & Telecommunication Contract Package (CP-203) and Electric Traction System Works under Contract Package (CP-204). Completion dates for the CST, Signalling & Telecommunication and Electrical contracts have been planned to be the same so as to facilitate integrated testing and commissioning of the entire section.

1.4 Objective

The objective of this Bid Document is construction of Signalling and Telecommunication system works for EDFC Phase-2 as a Design and Build Contract Package.

1.5 Scope of Work under Contract Package CP-203

1.5.1 The work under the scope of this Contract (Contract Package CP-203) consists of Design, Manufacture, Supply, Construction/Installation, Testing and Commissioning of Signalling, Telecommunication and Buildings & Structures (The Service Buildings for Signalling and Telecommunication work in the Block Sections) on Design and Build lump sum basis for EDFC Phase-2. The details of Track Sections, Stations, LC Gates, Maintenance Depots, OCC, Service Buildings, Residential Buildings, Club/Institue, Guest House and Traction Power System covered under EDFC Phase-2 is given in Clause 1.2 above.

1.5.2 The Works shall be based on "Employer's Requirements and Specifications as detailed in General Specifications (Volume 1 - Part 2 Section VI) and the relevant Particular Specifications (Volume 2, Volume 3 and Volume 4 - Part 2 Section VI).

(1) Signalling Works

Particular Specifications of Signalling Works, including Train Management System is given in Volume 2, Part 2, Section VI.

(2) Telecommunication Works

Particular Specifications of Telecommunication Works is given in Volume 3, Part 2, Section VI.

(3) Building & Structures Works

Particular Specifications of Building & Structure Works is given in Volume 4, Part 2, Section VI.

1.5.3 **Temporary Work**

The Contractor shall execute all Temporary Works required to facilitate construction/installation and the cost thereof shall be included in the overall bid price. All temporary arrangements and works shall be designed and necessary drawings developed to ensure safety during construction/installation. As a rule, Temporary Works shall be

subsequently dismantled and removed by the Contractor after construction/installation, at his own cost. The Engineer, however, may permit/instruct retention of some of the Temporary Works with mutual consent between the Contractor and the Engineer.

End of Chapter-1

CHAPTER 2 - GENERAL

2.1 Definitions

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

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

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

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

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

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

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

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

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

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

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

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

(12) **"Detailed Design"** prepared and accepted part of drawings, documents, standards and instructions which is the authorization for manufacture, procure/supply, construction/Installation and testing. "Detailed Design" has the meaning identified in Part 2, Employer's Requirements, Section VI, Volume I, Chapter-6, Design Requirements of the Bidding Documents.

(13) **"Design Criteria"** means the governing specifications and conditions as specified in Chapter-6 of this GS.

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

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

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

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

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

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

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

(21) **"Employer"** means the DFCCIL or the person named as Employer and the legal successors in title to this person

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

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

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

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

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

(27) **"Hazard"** physical situation with a potential for human injury and/or damage to environment

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

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

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

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

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

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

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

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

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

(37) **"Mean Time to Restore (MTTR)"** means the average time to restore equipment, subsystems, systems to full functionality.

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

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

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

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

(42) **"Other Contractor"** means the contractor(s) other than the Signalling and Telecommunication Contractor.

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

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

(45) **"Operating Hours"** means operating hours for Train Operation in EDFC shall be 24 Hours all days.

(46) **"Particular Specifications"** means the Specifications prepared for the purpose as enclosed as Volume 2, 3 and 4.

(47) **"Permanent Work''** means the permanent works to be designed and executed by the Contractor under the Scope of Work covered in this Contract.

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

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

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

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

(52) **"Possession"** means taking a section of the line out of service for engineering purposes.

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

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

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

(56) **"Reliability"** The probability that an item/equipment/system can perform a required function under given conditions for a given time interval. The measure of reliability is MTBF.

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

(58) **"Right of Way''** means the width/area of the land acquired/being acquired for the operation of the railway. Right of way for Phase-2 of the DFC project has been indicated in Part 4, Reference Documents.

(59) **"Safety"** freedom from unacceptable risk of harm.

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

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

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

(63) **"Sub-system"** Each system comprises of sub systems. Signalling System comprise sub systems of Electronic Interlocking System, Train Detection System, Point Operation System, Absolute Block Working, Power Supply System, Train Management System and Level Crossing Interlock System. Telecommunication System comprise sub systems of Optical Fiber Communication System, Data Networking System, GSM-R based Mobile Train Radio Communication System,

Telephone System, Emergency Communication System, VHF Communication System, Master Clock System and 48 volt DC Battery Backup System etc.

(64) "**Stations**" means Junction Stations and Crossing Stations of EDFC Phase-2 in Mugalsarai-New Bhaupur (excluding) section and given in Clause 1.2.4 above.

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

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

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

(68) **"Train Operator/Driver"** means the person on the train responsible for its operation.

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

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

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

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

(73) **"Works Program"** means the Program showing the sequence, method and timing of investigations, design, issue of No Objection Notices, execution, manufacture, delivery to site, erection, installation, testing, commissioning of the Works (including Integrated Testing and Commissioning), indigenization (where applicable) and related activities in the form and content prescribed by the Employer's Requirements, or any amended or varied version thereof, as submitted by the Contractor and for which the Engineer has issued a Notice of No Objection.

2.2 Abbreviations

AC	Alternating Current
ALARP	As Low As Reasonably Practicable

BS	British Standards
BTS	Base Transceiver Station
CAD	Computer Aided Design
CIP	Co-ordinated Installation Plan
CP	Contract Package
CPCB	Centre Pollution Control Board
CPM	Critical Path Method
CRS	Commissioner for Railway Safety
CSD	Combined Service Drawings
CST	Civil, Structure and Track
CV	Curriculum-Vitae
DC	Direct Current
DDF	Digital Distribution Frame
DFC	Dedicated Freight Corridor
DFCC	Dedicated Freight Corridor Corporation
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
DL	Double Line
DNP	Defect Notification Period
DT	Down Time
DTN	Data Transmission Network
DVT	Design Verification Table
EDFC	Eastern Dedicated Freight Corridor
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EMP	Environmental Management Plan
E&M	Electrical & Mechanical
EN	European Norm
ERP	Enterprise Resource Planning
FAT	Factory Acceptance Tests
FMECA	Failure Modes Effect and Criticality Analysis
FRACAS	Failure Report And Corrective Action System
FTA	Fault Tree Analysis
GE	Geotechnical Engineering
GSM-R	Global System for Mobile communication – Railway
GWR	Gate Working Rules
HT	High Tension
HTML	Hyper Text Markup Language

Hz	Hertz
ID	Identification
ICD	Interface Co-ordination Document
IEC	International Electro – technical Commission
IHA	Interface Hazard Analysis
IMD	Integrated Maintenance Depot
IMSD	Integrated Maintenance Sub-Depot
IMP	Interface Management Plan
IR	Indian Railways
IRS	Indian Railway Standards
IRSEM	Indian Railway Signal Engineering Manual
ISO	International Standards Organisation
IT	Information Technology
Km / KM	Kilo Meter
KV	Kilo Volt
KMPH	Kilo Meter Per Hour
LC	Level Crossing
LRU	Line Replaceable Units
LT	Low Tension
MCIL	Maintainability Critical Items List
MDF	Main Distribution Frame
MMI	Man Machine Interface
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
MTTR	Mean Time To Restore
MTBSAF	Mean Time Between Service Affecting Failure
NOC	No Objection Certificate
O&M	Operation and Maintenance
OCC	Operation Control Centre
ODBC	Open Data Base Connectivity
ODF	Optical Distribution Frame
OEM	Original Equipment Manufacturer
OFC	Optical Fiber Cable
OHE	Overhead Equipment
OHTL	Over Head Transmission Lines
O&SHA	Operating and Support Hazard Analysis
PMIS	Project Management Information System

PHA	Preliminary Hazard Analysis
PS	Particular Specifications
OPM	Other Preventive Measures
QA	Quality Assurance
RAMS	Reliability, Availability, Maintainability and Safety
RBD	Reliability Block Diagram
RDT	Reliability Demonstration Testing
RCIL	Reliability Critical Item List
RDSO	Research Design and Standards Organization
ROB	Road Over Bridge
ROW	Right Of Way
RUB	Rail Under Bridge
SCIL	Safety Critical Items List
SAT	System Acceptance Tests
SCADA	Supervisory Control and Data Acquisition
SER	Signalling Equipment Room
SHE	Safety, Health and Environment
SIL	Safety Integrity Level
SL	Single Line
SM	Station Master
SP	Sectioning Post
SRS	System Requirement Specifications
SSP	Sub-Sectioning Post
SSHA	Subsystem Hazard Analysis
S&T	Signalling & Telecommunication
SWR	Station Working Rules
TER	Telecommunication Equipment Room
TMS	Train Management System
TOT	Transfer of Technology
TSS	Traction Sub-Station
UPS	Uninterruptible Power Supply
VAT	Value Added Tax
VDU	Video Display Unit
VHF	Very High Frequency
WGS	World Geodetic System

2.3 Relevant Documents

Documents shall be read in conjunction with the Conditions of Contract (General and Particular), Employer's Requirement and any other document forming part of the Contract. This design-build contract shall be fulfilled, managed and commissioned in accordance with the applicable legislation/regulations/standards in India, and where none exist with applicable international norms as appropriate.

2.4 Patent, Copyright or Other Intellectual Property Rights

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

2.4.2 **Infringement of Patent Rights**

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

2.5 Climatic Conditions

2.5.1 The entire section from New Bhaupur to Mughalsarai is situated in the state of Uttar Pradesh. During summer months the temperature can be as high as 45°C with a high level of humidity, nights can be relatively cool with temperatures dipping to 30°C. Torrential rains and high humidity accompany the monsoon in late June to early September. In the winter months temperatures can vary from a high of 21°C during day to a low of 2°C during night.

2.5.2 The information given above is only indicative. The contractor shall obtain detailed climatic data in respect of minimum & maximum temperatures, rain, relative humidity, sun shine, and wind velocity/pressure etc. from "India Meteorological Department publications" and the same shall be taken into account by the Contractor when designing any part of the Permanent Works. The Contractor shall ensure that due allowance is made for more severe local conditions when Permanent Works are required to operate, for example, with restricted ventilation that may lead to higher local ambient temperatures, and any other factors that may affect the operating environment in any way.

2.5.3 Unless specific figures are provided elsewhere, the Permanent Works will generally be required to function at its rated value with the values of ambient temperature and relative humidity appropriate to the location of the equipment within the classifications shown in Table given below. Certain parts of the Permanent Works may need to be rated for more or less onerous conditions as required by the PS.

2.5.4 The Contractor's attention is drawn to the more severe environmental conditions that may exist during the construction/installation period and shall take adequate measures to protect the Permanent works against any deleterious effects of such conditions during the time between installation and final completion of the project. Also, Air throughout the project will contain considerable moisture content, hence the permanent works shall be tropicalized and vermin proof.

2.5.5 Classification of Equipment Environment

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

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

(2) All equipment shall be designed and tested in accordance with the given figures allowing a margin of at least 10% greater and 2°C less than the limits recorded. All designs for equipment shall work within the enclosures proposed with the specified environment outside the enclosure. The following are the minimum design requirements for equipment to be installed in each class of environment. Where any class does not have a value for a parameter the most extreme value quoted for the lesser class environments should be used. For any equipment that is proposed to be installed in more than one environmental clause, the design shall take into account the most severe environmental class conditions.

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

(b) Requirements for Class B	
Minimum Temperature	-2.5°C (B1) and (B2)
Ambient Temperature	30°C (B1) and 50°C (B2)
Maximum Temperature	45°C (B1) and 55°C (B2)
Relative Humidity	Nominal 70%, Maximum 100% (Non condensing)
Air Quality	Polluted and dusty - SO_2:80-120mg/m3 Suspended Particulate Matter: 360-540mg/m3
Electrical Noise	Impulse 1kV, 1.2/50 rise/decay, 500Σ source impedance, 0.5J source energy.
Radio & High Frequency	as Class A.

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

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

End of Chapter-2

CHAPTER 3 – PROJECT PROGRAMME REQUIREMENT

3.1 General Requirements

3.1.1 The Contractor shall develop in detail, a logical method of executing the Works taking into account their complex nature and different phases and shall provide programmes which reflect the detailed planning undertaken.

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

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

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

3.1.5 The critical path shall be clearly identified in the programme and fully described in the accompanying programme narrative.

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

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

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

3.2 The Execution Phases

The execution activity will include various phases of the implementation as under.

(1) Design Phase,

(2) Manufacturing/Supply Phase,

(3) Construction/Installation Phase,

(4) Testing & Commissioning Phase and

(5) Operation & Maintenance Phase;

3.2.1 Design Phase

The contractor shall deploy a qualified team of the Design Engineers and Experts as approved by the Employer, evidencing the experience of the design in relevant field and

technology with the approval of the Engineer, before commencement of Design Phase. The Design Phase shall have 4 stages as detailed below:

(a) Preliminary Design
(b) Detailed Design
(c) Construction / Installation Design
(d) As Built Documents

3.2.2 **Manufacturing /Supply Phase**

The manufacturing /supply will constitute the following:

(a) Manufacturing/Procurement;
(b) Factory Acceptance Tests (FAT);
(c) Delivery to the contractor's stores at site; and
(d) Storage at the site Stores, including establishing the Material Procurement tracking, receipt and issue procedures.

3.2.3 **Construction/ Installation Phase**

Construction/ Installation Phase will constitute of the following:

(a) Site Management including access/ ROW preparation;
(b) Availability of Construction reference Drawings;
(c) Installation preparatory works like Foundations, first fix, site safety and quality assurance procedures etc.;
(d) Equipment installation; and
(e) Training of Employer's Personnel

3.2.4 **Testing and Commissioning Phase**

Testing and commissioning phase will constitute of the following:

(a) Testing and Commissioning of all subsystems;
(b) Quality assurance;
(c) Integrated Testing & commissioning;
(d) Trial run including service trials; and
(e) Submission of verified and As Built Documents

3.2.5 **Operation and Maintenance Phase**

Operation and Maintenance Phase will constitute of the following

(a) Operation and Maintenance activity
(b) Defect rectification
(c) Workshop Repair Services
(d) Support and Call Out Services
(e) RAMS demonstration
(f) Supply of O & M Manuals, Maintenance schedules

3.3 Works Programme

3.3.1 The Works Programme to be submitted under the contract shall be developed from the Outline Works Programme submitted and developed during the tender period.

3.3.2 Within 30 days of the Commencement Date of the Works the Contractor shall submit for review by the Engineer, his proposed initial version of the Works Programme which shall

provide full programme details for the first six months of the contract and shall provide outline details for the remaining period of the contract.

3.3.3 Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer the proposed full version of the Works Programme.

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

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

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

(1) All works comprising the permanent works;

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

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

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

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

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

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

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

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

(10) Testing and commissioning activities requirements.

(11) Training.

3.3.7 The Works Programme shall be divided into Sub-Programmes of manageable size addressing in more specific detail, the content of the Management Plans. The Sub-Programme shall be as follows:

(1) Design Submission Programme

(2) Procurement and Manufacturing Programme;

(3) Installation Programme

(4) Testing and Commissioning Programme; and

(5) Training Programme

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

3.3.9 The Sub-Programmes shall be further substantiated by the supplementary programmes as required by the Engineer.

3.3.10 The Contractor's Works Programme shall comply with the following;

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

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

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

(4) The planning unit for the duration of all programme activities shall be the day. Any activity having a duration of more than thirty (30) days shall be divided into sub activities that shall not exceed thirty days.

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

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

(a) Major manpower for both design and installation.

(b) Number of items of Contractor's Equipment.

(c) Number of drawings and other design deliverables.

(d) Principal quantities of components or parts.

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

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

3.4 Design Submission Programme

3.4.1 The Contractor shall, within 30 days of the Commencement Date of the Works submit a Design Submission Programme covering all proposed submissions to the Engineer. The Design Submission Programme shall be broken down into a submission programme for each of the Management Plans of which shall define the dates for individual submissions and shall confirm to the base line dates shown in the Works Programme.

3.4.2 The Submission Programme shall include the requirements of the Design Submission including the procurement activities of all sub-contractors and suppliers.

3.4.3 The Submission Programme shall include each submission for every item listed in the Specification as being required to be submitted.

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

(1) Progress of design, manufacture, installation and testing work;

(2) Co-ordination with other Contractors; and

(3) Including due allowance for the Engineer review process to be undertaken, including the time needed for any re-submissions.

3.4.5 The Design Submission Programme shall specifically include a date of submission by the Contractor of the Final Design on completion of the Preliminary Design stage. The Final Design shall include at least but not limited to; details showing all of the proposed equipment, interconnections, physical layout, installation locations and interfaces to other suppliers.

3.5 Procurement and Manufacturing Programme

3.5.1 Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer a procurement and manufacturing programme that shall be an integrated part of the overall Works programme.

3.5.2 The Procurement and Manufacturing Programme shall show the interdependencies between Engineering disciplines as well as between the contractor and its subcontractors and suppliers. This programme shall demonstrate compliance with the requirements of the Submissions Programme.

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

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

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

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

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

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

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

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

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

3.5.7 The Contractor shall submit, as part of the Procurement and Manufacturing Programme, a Factory Testing Programme that shall support all aspects of the Factory Testing Plan.

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

3.5.9 The Factory Testing Programme shall demonstrate the logical dependencies between the individual tests of the works, and shall also show the interfaces and dependencies with the contractors delivery programme.

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

(1) First article inspection;

(2) Quality Hold Points;

(3) Quality Control Points;

(4) Type Tests; and

(5) Routine Tests.

3.6 Installation Program

3.6.1 The Installation Programme shall be submitted as stated in the PS or as directed by the Engineer. The Installation Programme shall comply with the requirements of clause 3.3.10 above.

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

3.6.3 The Installation Programme shall be fully supported by the Construction and Installation Management Plan.

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

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

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

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

3.6.8 In preparing the Installation Programme, the contractor should note that the following conditions shall apply:

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

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

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

(4) The Contractor shall comply with the identified Milestone Dates identified in the contract.

3.7 Testing and Commissioning Programme

3.7.1 The Testing and Commissioning Programme shall be submitted as stated in the PS or as directed by the Engineer and shall comply with the requirements of the clause 3.3.10 above.

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

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

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

3.8 Training Programme

3.8.1 The Contractor shall, within 280 days of the Commencement Date of the Works, submit for review by the Engineer, a Training Programme covering all proposed formal training courses, delivery of training equipment and accesses by the Employer's personnel.

3.8.2 The Training Programme shall be developed to the Training Plan as required.

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

3.8.4 The Training Programme shall include the requirements of Chapter-13, including the Training activities of all sub-contractors and suppliers.

3.9 The Project Calendar

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

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

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

3.10 Programme Submissions

3.10.1 The Contractor shall submit all programmes described in this Chapter in conjunction with the Management Plans described in Chapter-4 to the Engineer.

3.11 Programme Review

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

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

3.12 Works Programme Revisions

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

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

3.13 Monthly Progress Report

3.13.1 The Contractor shall prepare Monthly Progress Reports covering all aspects of the execution of the Works. Such Monthly Progress Reports shall be in writing and shall be delivered to the Engineer by the 7th day of the month following the month of Monthly Progress Report. The Monthly Progress Report shall take account of work performed upto and including the last day of the month to which the monthly progress report relates and shall be prepared in accordance with Annexure-3.

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

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

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

3.13.5 **Progress Photographs and Videography for Monthly Progress Report**

(1) The Contractor shall provide monthly progress photographs which have been properly recorded to show the progress of the works to the Engineer. All important events shall be photographed.
(2) Two sets of photographs shall be provided on electronic storage device with two sets of colour prints of 175 mm x 125 mm size.
(3) The Contractor shall mount each set of each month's progress photographs in a separate album of a type to which the Engineer has given his consent and shall provide for each photograph two typed self-adhesive labels, one of which shall be mounted immediately below the photograph and one on the back of the photograph.
(4) Each label shall record the location, a brief description of the progress recorded and the date on which the photograph was taken.
(5) All photographs shall be taken by a skilled photographer whose name and experience shall be submitted to the Engineer for consent and approval received.
(6) The Contractor shall ensure that no photography is permitted on the Site without the consent of the Engineer.

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

3.14 Programme Analysis Report

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

(1) cycle times and work sequences;
(2) the deployment of Contractor's Equipment and labour;
(3) the production rates used in determining duration;
(4) the shifts assumed in determining duration;
(5) the breakdown of labour requirements by trades;
(6) the schedules of quantities used in developing the programme, to the extent that such information is not provided elsewhere;
(7) interfaces with the Engineer and Project Contractor's and other constraints; and
(8) any assumptions used in the programme.

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

3.15 Progress Meetings

3.15.1 The Employer/Engineer will chair progress meetings every month with the Contractor. These meeting will be held at dates and times to be advised by the Engineer. Progress meetings shall not be later than 10 days after the issue of contractor's monthly progress report.

3.15.2 The Engineer may convene at his discretion, at any time upon reasonable notice to the contractor, any meeting, either on or of the Site, to discuss and address any aspect of the Works or the Contract. The Contractor shall attend any such meetings convened by the Engineer.

3.15.3 All meetings shall be convened either at site or as directed otherwise by the Engineer. Meetings shall be attended by senior personnel from the Contractor who shall arrive properly briefed for all aspects of the meeting and shall be empowered to make executive decision in respect of the execution of the Works.

3.16 Quarterly Review Meetings

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

3.16.2 Quarterly Review Meetings shall be held to review the overall progress of the Works in the context of the Project as a whole and to address and resolve any issues relevant to the execution and progress of the Works. Such Quarterly Review Meetings will be chaired by the Employer or his delegate. The Contractor shall have in attendance of one senior representative from each of the companies comprising the Contractor, if it is a Joint Venture, Consortium or Partnership at such Quarterly Review Meetings.

3.16.3 The Contractor shall submit names of the persons whom the Contractor proposes to attend each Quarterly Review Meeting to the Engineer for review not less than 7 days prior to each Quarterly Review Meeting.

3.17 IT Requirement for DFCCIL

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

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

- Ensure that required data of the Contracts Work Program and Physical progress of the activities defined in the Works Program must be provided in the templates defined by DFCCIL to be uploaded in the system using software defined by DFCCIL.
- Work Program, Revised Works Program and Revision in Planned Work in the Activities, would also be uploaded in the system using software defined by DFCCIL through templates provided by it.
- In order that the Works Program Data provided by the Contractor could be uploaded as it is in the system, Contractor must adhere to the following conditions regarding the

length of the Codes/Numbers defined in their project Management Tool (e.g. Primavera or Microsoft) for the Project Structure Elements:

a) Project ID/WBS Element Codes/Numbers must be unique and must not exceed a maximum length of 20 Characters (Alpha Numeric).
b) Activity IDs/Numbers must not exceed a maximum length of 4 Characters (Alpha Numeric).

- Upload of drawings and designs created by Contractor as per the classification using document management system of SAP.
- Online measurement book entry (Record of Works) and all bills along with supporting documents as per the screens defined by DFCCIL.
- Asset details needs to be updated in the system in format prescribed by DFCCIL.
- GIS (Geographical Information System) application will use Autodesk suite (MAP 3D as desktop GIS & AIMS for WEB GIS) and Oracle 11g/spatial as a central repository. Information about the assets details (i.e. alignment drawing coordinates and attributes) will be provided by the contractors. Network asset details in the form of maps, reports will be available to all the authorized users through web as soon as the asset details are submitted by the contractors and imported in the system.

a) Geo-referencing of alignment on WGS-84 coordinates.
b) Capture and upload of geo-referencing coordinates of the assets in to GIS.

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

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

End of Chapter-3

CHAPTER 4 – MANAGEMENT PLANS AND SUBMISSIONS

4.1 General

4.1.1 In order to ensure the Contractor understands and complies with the requirements of the Contract, a series of Management Plan shall be developed. These Management Plans will serve to structure the submittals in a manner that the Contractor can develop and prepare the submittals and the Engineer can review and comment on a prescribed programme.

4.1.2 The Management Plans shall be configured as a family of "stand-alone" plans and associated documents, each covering one of the subjects listed below.

The plans and documents shall be co-ordinated with each other and shall collectively define describe and encompass the Contractor's proposed methods, procedures, processes, organisation, sequencing of activities etc. and shall show how these combine together to assure that the work truly meets the requirements of the specifications in respect of the subject listed.

Unless otherwise stated in the PS, all plans and documents shall be submitted in preliminary form within 60 days of the Commencement Date of the Works followed by detailed plan within 45 days of the preliminary submission. Further submissions shall be made:

(1) when required in accordance with the Works Programme;
(2) whenever the development of the Contractor's designs or planning allows the plan to be developed further;
(3) in response to comments made by the Engineer:
(4) whenever any change occurs that invalidates the information contained in the previously submitted and reviewed document, within 14 days of the occurrence of such change; and
(5) when requested by the Engineer from time to time.

4.2 General Organisation

4.2.1 The plans listed below shall be developed and submitted by the Contractor for the Engineer's review:

Project Management Plan
- Contractor's Project Plan
- Interface Management Plan

Systems Assurance Plan
- Quality Plans
- RAMS Plan
- Electromagnetic Compatibility Management Plan
- Software Quality Assurance Plan

Design, Procurement and Manufacturing Management Plan
- Design Plan

- Design Verification and Validation Plan
- Factory Testing Plan
- Procurement, Manufacturing and Delivery Plan

Construction and Installation Management Plan
- Construction and Installation Plan
- Safety, Health and Environment Management Plan

Completion Management Plan
- Commissioning Plan
- Operational and Maintenance Manuals Plan
- Training Plan
- Spares Management Plan
- Defects Liability Management Plan

4.3 Project Management Plan

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

4.3.1 **Contractor's Project Plan**

4.3.1.1 The Contractor's Project Plan shall provide a clear overview of the Contractor's organisation, management systems and methods to be used for complete execution of the Works.

4.3.1.2 The Contractor's Project Plan shall include a summary description of each and every stage of implementation of the Works, clearly showing the principal organisational interfaces both within the Contractor's own organisation (including sub-contractors of every tier) and with Other Contractors and Relevant Authorities, defining how each of these interfaces is to be managed and controlled. An organisation chart shall be produced to illustrate the subdivision of the work into elements for effective technical and managerial control, the reporting structure and the interface relationship among all parties involved. Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

4.3.1.3 The Contractor's Project Plan shall contain structured organisation charts showing the hierarchical relationship of the Contractor's organisation (including sub contractors of every tier). The organisation charts shall be produced as a "family" such that the basic chart shows the overall organisation structure supported by subsidiary charts detailing the internal structure of various departments or sections of the overall organisation.

4.3.1.4 The Contractor's Project Plan shall include full details of the qualifications, experience, authority and responsibility of the personnel assigned to all key positions of the Contractor's organisation (including sub contractors of every tier). As a minimum, this shall include all levels down to senior managers and shall include the personnel responsible for each individual department and functional group. A clear reference shall be given as to the location

of staff (e.g. site resident or factory based, etc). Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

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

(1) the procedure for audit;
(2) the procedures for the control of receipt and issue of all Works related correspondence so as to ensure traceability;
(3) the procedures for filing system to be implemented to maintain the Contractor's records during the course of the work. The filing systems used by the Contractor and sub contractors of any tier shall be compatible as for as is necessary;
(4) the procedures for the identification, production, verification, internal approval, review (when required) by the Engineer, distribution, implementation and recording of changes to all drawings, reports and specifications;
(5) the procedures for the evaluation, selection, engagement and monitoring of sub-contractor/suppliers together with the means of application of quality assurance to their work including audit and acceptance;
(6) the procedure for the regular review and revision of each type of quality plan and its supplemental individual specific quality plans to ensure their continuing suitability and effectiveness, in addition to the methods to be used for revision and issue of revised documentation;
(7) the procedures for the control, calibration and maintenance of inspection, testing and measuring equipment;
(8) the procedures for the selection, indexing, disposition and maintenance of project record for storage in the archives. A list of items to be archived, including their periods of retention shall be submitted for review by the Engineer;
(9) the procedures for identifying training needs and for the provision of training of all personnel performing activities affecting quality; and
(10) the procedures for the control of non-conformity.

4.3.1.6 The Contractor's Project Plan shall include details of Contractor's Main Site Office to be located at Allahabad and other Site Office(s) to be located throughout Mughalsarai-New Bhaupur Section.

4.3.2 **Interface Management Plan**

(1) The Contractor shall interface and liaise with Other Contractor(s) in accordance with the requirements of Chapter-10.

(2) The Contractor shall develop and submit to the Engineer an Interface Management Plan that is mutually accepted to both the Contractor and the Other Contractor(s). The Interface Management Plan shall:

(a) identify the sub-systems as well as the civil & electrical works and facilities with interfacing requirements;
(b) define the authority and responsibility of the Contractor's and other Contractors' (and any relevant sub-contractors') staff involved in interface management and development;
(c) identify the information to be exchanged, together with the management and technical skills required for the associated development work, at each phase of

the Contractor's and other Contractors' (and any relevant sub-contractors') project life-cycles;

(d) include considerations of the Interface Hazard Analysis;

(e) specify the configuration and version control procedures in accordance with the Contractor's and other Contractors' (and any relevant sub-contractors') quality management system; and

(f) address the design, supply, installation, testing and commissioning programme of the contracts to meet the milestones of each contract, and highlight any programme risks requiring management attention.

(3) Once the Interface Management Plan has been reviewed without objection by the Engineer, the Contractor shall execute the Works in accordance with the Interface Management Plan. The Contractor shall advise the Engineer immediately of any difficulty in developing a mutually acceptable interface management plan.

(4) Within 90 days of notification from the Engineer of the identity of each Other Contractor, the Contractor shall develop and submit to the Engineer for review a Coordinated Interface Document (CIP) for each Other Contractor that is mutually acceptable to both contractors. The Coordinated Interface Document shall address in detail how the dates identified in the Interface Management Plan shall be achieved and shall identify the data required by the interfacing Other Contractor(s) to meet the requirements of the PS.

(5) The Coordinated Interface Document shall specify the proposed method and schedule for verifying the interface integrity, the individual equipment/ system performance and the combined system performance. The coordinated interface document shall include a program of tests to demonstrate the performance and integrity of the integrated systems. The interface requirements included shall form the basis of the coordinated interface document, but does not relieve the contractor's obligation to identify any new interface to meet the Contract requirements. Any revision to the coordinated interface document shall be mutually acceptable by contractors and submitted to the Engineer for review.

4.4 Systems Assurance Plans

4.4.1 The Systems Assurance Plans shall be submitted for review to the Engineer in Preliminary and Final forms.

4.4.2 Various plans shall be co-ordinated with each other and shall collectively define, describe and encompass the contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc and shall show how these combine together to assure that the Works truly meets the requirements of the specifications in respect of the subjects listed.

4.4.3 **Quality Plans**

The Contractor shall submit for review by the Engineer quality plans in accordance with the requirements of Chapter-11.

4.4.4 **RAMS Plans**

4.4.4.1 The Contractor shall implement a formal Reliability Plan and a formal Maintainability Plan in accordance with the PS.

4.4.4.2 The Contractor shall submit for review by the Engineer the Contractor's Reliability Plan and Maintainability Plan in accordance with the requirements of the Chapter-12. The Contractors Reliability Plan and a Maintainability Plan shall include Failure Modes, Effects and Criticality Analysis and the production of a Reliability Critical Items List.

4.4.4.3 The contractor shall submit for review by the Engineer the Contractor's Systems Safety Plan. The Systems Safety Plan shall address all the factors referenced in this Specification and as required by the PS.

4.4.5 **Electromagnetic Compatibility Management Plan**

(1) The Contractor shall prepare and submit for review by the Engineer, EMC Management Plan which shall, based upon a top-down approach, define the EMC philosophy, activities, means of control for the design processes and EMC submissions to be supplied to demonstrate compliance with the PS and GS.

(2) The EMC Management Plan shall identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the Employer's Representative for review. The EMC Management Plan shall also include a programme that shall identify the dates for EMC submissions.

(3) The EMC Management Plan shall include an initial list of design documentation, test specifications land test reports with a single paragraph description of each document to indicate compliance with the Specification.

(4) The EMC Management Plan shall include a definition and description of the process and methods used for Verification and Validation that the Works will achieve the required EMC parameters in all aspects.

(5) The Contractor shall co-ordinate the levels of interference emissions and susceptibility of all equipment which are to be designed, manufactured, supplied and installed by the Contractor and its sub-contractors and suppliers. The Contractor shall designate a person as point of contact to deal with EMC matters. Details of the nominated person and any subsequent change of the nominated person shall be subject to review; by the Employer's Representative.

(6) The Contractor shall liase and co-ordinate with all Other Contractors in the exchange of EMC data a related equipment performance characteristics and advises the Employer's Representative when any such information is requested from any Other Contractor. A copy of all EMC related information exchange shall be sent to the Employer's Representative for review.

(7) The Contractor shall comply with the following EMC requirements:

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

(b) EMC considerations shall be incorporated in the Contractor's procedures for product safety and design Verification.

(c) The design shall ensure that any electromagnetic interference emissions introduced into the environment do not exceed those detailed in the PS and GS. The Contractor shall ensure that the specified electromagnetic compatibility (EMC) requirements are adequate. Any shortcomings shall be made known to

the Employer's Representative immediately and recommendations for corrective action formulated.

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

(e) The Contractor shall detail the methodology used in support of the analysis. Contractor shall prepare and submit to the Engineer for review reports of the validation of the models.

(f) The Contractor shall supply documentation showing how system safety and reliability is ensured. It shall include Failure Mode, System Failure, the effect of human intervention, how equipment has failed thresholds that have been set in order to keep them above worst case interference levels, and how equipment tolerances and other characteristics in the Specifications have been allowed for in designing the system.

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

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

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

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

4.4.6 Software Quality Assurance Plan

Where software is a design deliverable, the Contractor shall submit a Software Quality Assurance Plan in accordance with the requirements of Clause-11.9. The Software Quality Assurance Plan shall address all elements of the design and development of software required as part of the Works.

4.5 Design, Procurement and Manufacturing Plan

The Design, Procurement and Manufacturing Plan shall be configured as a family of "stand-alone" plans and associated documents each covering one of the subjects listed below. The plans shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization,

sequencing of activities, etc. and shall show how these combine together to assure that the Works fully meet the requirements of the Specification in respect of the subjects listed.

4.5.1 **Design Plan**

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

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

4.5.1.3 Preliminary Design Stage

The Contractor shall prepare and submit to the Engineer for his review a System Requirement Specification (SRS) which includes, as a minimum, operational, functional, performance and design requirements of the proposed system.

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

(2) The System Requirement Specification shall include a compliance matrix that includes cross-references to the requirements stated in the PS, the System Requirement Specification and the Design Verification Table (DVT).

(3) The preliminary design stage, as a minimum, shall identify the function of each system, sub-system, equipment or other element within the overall SRS and specify the relationships and interfaces between each element of the system, including the systems of the interfacing elements of other Contractors.
Further the preliminary design stage shall address each element of the SRS as developed in the Preliminary Design. Equipment and interconnection specifications, with supporting calculation, shall be developed at this stage. Design of the overall system and elaborating on the proposed system configuration with emphasis on how the interface requirements are to be achieved shall be included in the preliminary design. Manufacturing of production units will only be allowed to commence after receiving a notice of no objection for the relevant design elements.

(4) Preliminary electrical and control schematics shall be developed to illustrate how the various operational and functional requirements can be achieved. Software design and development shall also be carried out during this stage.

(5) The submission shall clarify and confirm as necessary all technical aspects of all interfaces with other elements of the Contractor's overall design and of any interfaces with works being supplied by other Contractors.

(6) Ergonomic design, shall be developed as part of the preliminary design.

(7) If at any time in the development of the preliminary design, the Contractor wishes to modify the conceptual design by dividing any system or sub-system into a number of smaller systems or by reconfiguring the interfaces or for any other reason, the Contractor shall resubmit the SRS and/or the Preliminary Design for the Engineer review.

(8) A detailed submission list for the preliminary design shall be submitted to the Engineer for review prior to the start of the preliminary design. The submission shall be in sufficient detail to evaluate the progress and technical adequacy of the selected design approach.

(9) A series of Design Reviews shall be arranged prior to the conclusion of the preliminary Design Stage.

4.5.1.4 Detailed Design Stage

Upon completion of the Preliminary Design Stage the Contractor shall submit for review by the Employers Representative a homogeneous Detailed Construction /Installation Design.

4.5.1.5 Construction / Installation Design Stage

Installation detail and method statements for various areas and sections shall be released progressively during this stage. Installation works on Site will only be allowed to commence following the Engineer review of the relevant design information with no objection raised.

Separate parts of the design plan shall be prepared for Contractor and subcontractor design activities. The design plans shall define the Contractor's policy for the design of the Works and shall, without limitation, define:

(1) the organization of the Contractor's design staff with particular reference to the design interfaces;

(2) the specific allocations of responsibility and authority given to identified design staff with particular reference to the review and Verification of design specification, drawings and calculations by the Contractor;

(3) the specific methods of design necessary to identify any relevant method statements and develop those method statements to a sufficient degree of detail reviewed by the Engineer ; and

(4) the list of procedures and work instructions to be applied to manage and control the quality of the design work, including without limitation:

(a) the design and performance requirements which shall be defined in terms of basic data and design assumptions made; relevant codes, standards and regulatory requirements, safety, reliability, security and environmental requirements; and commissioning requirements;

(b) the design methods, software applications to be used in the design, both proprietary and public domain, including any requirements for physical and mathematical model testing;

(c) the preparation, checking, issue, distribution, indexing and filing of reports, calculations, drawings and specifications together with the means for their revisions;

(d) the formal design review, authorization and approval of design documentation; and

(e) the independent design Verification and Validation.

4.5.2 **Design Verification and Validation Plan**

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

(1) the objectives of each Verification phase and each Validation phase;
(2) defined input and output criteria for each development phase;
(3) identification of types and detailed methods of test, Verification and Validation activities to be carried out;
(4) detailed planning of Verification and Validation activities to be carried out, including schedules, resources and approval authorities;
(5) selection and utilization of the test equipment, and their test environmental conditions; and
(6) criteria on which the Verification or Validation is judged to be acceptable. These criteria shall be traceable to the design and performance requirements.

4.5.2.2 The Contractor shall, by means of a design Verification and Validation process, demonstrate that all requirements within the Specification have been met. The Contractor shall prepare a Design Verification Table (DVT) that identifies the Contractor's proposed methodology for demonstrating compliance.

4.5.2.3 The DVT shall be supplied to the Engineer for his review and shall be monitored throughout the design and construction of the Works. Any changes to the DVT must be submitted to the Engineer for review before implementation.

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

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

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

(1) Similarity – equipment and requirement are identical to those successfully applied on other projects.
(2) Historical – requirement has been met by numerous previous design.
(3) Calculations and Drawings – for review.
(4) Design Review – either scheduled or specifically targeted.
(5) Development Test – performance testing on equipment or material under development.
(6) Type Test – performance testing of the as-built component, assembly or system.
(7) Routine Test – test every component, assembly or system.
(8) First Article Inspection (FAI) – acceptances of the exact look and fit of equipment.
(9) Inspection – formal inspection of the finished item.
(10) In Service – for service demonstration requirements only.

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

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

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

4.5.3 Factory Testing Plan

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

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

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

(2) the sequencing and interrelationships of the inspections and tests including:

(a) all Quality Hold Points; and
(b) all Quality Control Points;

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

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

(5) organisation chart and CV of key personnel in inspection and test team;

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

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

4.5.3.2 The Contractor shall arrange for all equipment and systems manufactured for incorporation into the Permanent Works to undergo a Factory Acceptance Test (FAT) before shipment from the place of manufacture. Any particular requirements for inspection and testing at the place of manufacture are prescribed in the PS.

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

4.5.3.4 Inspections and tests that are to be witnessed by the Employer or the Engineer shall be sensibly grouped and scheduled so that as many inspections and tests as possible may be witnessed during a single visit.

4.5.3.5 If required, Type Tests as detailed in relevant Particular Specifications shall be performed on all items of equipment to be installed as part of the Permanent Works under the Contract. The Type testing shall be based on the environmental class of the sites into which the equipment will be installed.

4.5.3.6 For all production items a First Article Inspection shall be undertaken as detailed in relevant Particular Specifications. Routine production testing methods shall be detailed for review by the Engineer. Routine testing shall ensure that all samples of a production item are within the tolerances required for complete interchangeability.

4.5.3.7 The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Engineer. If the Employer or the Engineer has witnessed the inspection or test, he will countersign the inspection or test report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein. If the Employer or the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or the Employer or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Employer or the Engineer may call for a re-inspection or re-test.

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

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

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

4.5.4 **Procurement, Manufacturing and Delivery Plan**

4.5.4.1 The Contractor shall prepare procurement, manufacturing and delivery plans in respect of all items and goods. Separate parts of the plan shall be prepared for Contractor or sub-contractor off-site activities. Each plan shall identify the scope of work to be applied. In relation to such scope of work, it shall, without limitation, define:

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

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

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

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

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

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

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

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

(d) the inspection and testing of incoming materials, in process and final product so as to ensure specified requirements for the material and/or manufactured product are met;

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

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

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

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

(i) the handling, storage, packaging, preservation and delivery of manufactured product.

4.5.4.2 The Contractor shall prepare and submit the inspection and testing plans to manage and control any test and inspection activities in accordance with clause 4.5.3 above;

4.5.4.3 The Contractor shall propose a structured set of inspection hold points. The hold points shall be structured such that a formal hold point is allowed for each significant element of the manufacturing process. At each hold point, the Engineer shall hold a formal inspection or advise that the inspection had been waived.

4.5.4.4 Once the inspection and any required remedial actions are completed to the satisfaction of the Engineer, the Engineer shall not withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has been successfully completed.

4.5.4.5 Any unit delivered without the Engineer notice of no objection shall be rejected at the Site and all expenses thereby shall be borne by the Contractor.

4.6 Construction and Installation Management Plan

The Construction and Installation Management Plan shall be configured as a family of "stand-alone" plans and associated documents each covering one of the subjects listed below.

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

4.6.1 Construction and Installation Plan

4.6.1.1 The Contractor shall prepare plans for the construction and installation activities on and off the site, as referred in Chapter-7 and shall ensure that these are properly related to the subsequent testing and commissioning activity.

4.6.1.2 Separate parts of the plan shall be prepared for other contractor(s) or sub-contractor(s) off-site activities.

4.6.1.3 Each construction plan shall identify the scope of activity to be controlled. In relation to scope of such activity, it shall, without limitation, define:

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

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

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

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

(5) a detailed method statement which shall include but not be limited to;

(a) description of main operations and sub-operations;
(b) sequence of sub-operations;
(c) quantities of the work and production rates to be achieved;
(d) resources to be employed; and
(e) quality checks to be carried out, supervision being exercised and safety precautions to be employed;

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

(a) the inspection and testing activities of incoming materials, in process and final product so as to ensure specified requirements for the material and/or product are met;
(b) the purchasing of materials and ensuring they comply with the requirement of the specification, including purchasing documentation and specific Verification arrangements for Contractor/Engineer inspection of material or manufactured product prior to release for use/installation;
(c) the construction processes including Temporary Works so as to ensure compliance with drawings and specification. In addition, any software to be used in construction, installation and commissioning process shall be identified and details of the Verification and validation processes for the software application shall be given;
(d) the construction and installation process so as to ensure clear identification and traceability of material and manufactured product;
(e) the identification of the inspection and test status of all material and manufactured product during all stages of the construction and installation process to ensure that only products that have passed the inspections and tests are despatched for use and/or installation;
(f) review and disposition of non-conforming material or product so as to avoid unintended use/installation;
(g) the assessment and disposition of non-conforming material and product and approval of reworking or rejection as scrap;
(h) the identification of preventive action so as to prevent recurrence of similar non-conformance; and
(i) The handling, storage, packaging, preservation and delivery of product; and

4.6.1.4 The Contractor shall prepare and submit inspection and test plans to manage and control any test and inspection activities in accordance with Chapter-7.

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

4.6.1.6 The following particulars shall be submitted to the Engineer for review within 28 days of the Commencement Date of the Works;

(1) drawings showing the layout within the Site of the Contractor's accommodation, project signboards, access roads and major facilities required early in the Contract;
(2) drawings showing the details to be included on Project signboards.

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

4.6.2 **Safety, Health and Environmental Management Documentation**

4.6.2.1 The Contractor shall submit Safety and Health Documentation to fully comply with the requirements of the project conditions and proposed work activities in accordance with Chapter-9.

4.6.2.2 The Contractor shall submit to the Engineer the Safety and Health Documentation for review within 30 days of the Commencement Date of the Works.

4.6.2.3 The Contractor shall within 112 days of the Notice to Proceed submit an Environmental Management Plan based the Outline Environmental Plan submitted and adapted during the Tender period.

4.6.2.4 The Contractor shall submit for review by the Engineer, an Environmental Management Plan which will set out in detail the approach for dealing with each of the potential impacts arising from various different construction activities.

4.6.2.5 The EMP shall address all the potential impacts outlined in the Employer's Final Assessment Report and shall follow the EMP Outline contained in Chapter-9.

4.6.2.6 The Contractor shall submit the Final EMP for review by Engineer, 30 days prior to the commencement of construction activities.

4.7 Completion Management Plan

4.7.1 The Contractor shall organise the services required under the Contract to bring the Works into service under one plan. This co-ordinated approach shall allow the Engineer, The ability to review all aspects of the Works and services in an integrated manner.

The Completion Management Plan shall be configured as a family of "stand-alone" plans and associated documents, each covering one of the subjects listed below.

The plans shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organisation,

sequencing of activities etc., and shall show how these combine together to assure that the Works truly meet the requirements of the Specification in respect of the subjects listed.

4.7.2 **Commissioning Plan**

4.7.2.1 The Contractor shall ensure the timely preparation of the Commissioning Plan in a format and to a level of detail in accordance with clause 4.7.2.2 below. The Contractor shall submit the first draft of the Commissioning Plan to the Engineer within 180 days of the Commencement Date of the Works.

4.7.2.2 The Commissioning Plan shall consist of the following:

(1) Installation Tests Schedule

The Contractor shall submit to the Engineer a comprehensive schedule of the installation tests as required by relevant PS and in accordance with the Installation Programme. The schedule shall be submitted within the period of time laid down in the PS, or, if none is given, not later than two months in advance of the date for the commencement of the Installation Tests.

(2) System Acceptance Tests Plan

The Contractor shall submit to the Engineer, a comprehensive System Acceptance Tests Plan including all requirements detailed in the relevant PS. The plan shall be submitted within the period of time laid down in the PS, or, if none is given, not later than four months in advance of the date for the commencement of the System Acceptance Tests.

(3) Integration Testing & Commissioning Plan

The Contractor shall submit to the Engineer a comprehensive Integrated Testing and Commissioning Plan including all requirements detailed in PS. The plan shall be submitted within the period of time laid down in PS, or, if none is given not later than four months in advance of the date for the commencement of Integrated Testing and Commissioning.

4.7.3 **Operation and Maintenance Manuals Plan**

4.7.3.1 The Contractor shall develop an Operation and Maintenance Manuals Plan to suit staged commissioning of the system and to ensure timely preparation of the Operation and Maintenance Manuals and the “As-Built” Drawings in a format and to a level of detail reviewed without objection by the Engineer and in accordance with the Clause-14.5.

4.7.3.2 The Contractor shall submit the Operation and Maintenance Manuals Plan not later than 266 days prior to the issue of the Taking Over certificate for the works and according to the staged commissioning, if applicable, of the proposed systems.

4.7.4 **Training Plan**

4.7.4.1 The Contractor shall ensure the timely preparation of the Contractor’s Training Plan in a format and to a level of detail reviewed without objection by the Engineer and fulfilling the requirements of Chapter-13.

4.7.4.2 The Contractor shall submit the Training Plan by the date stated in the PS, or, if none is given, not less than three (3) months prior to the start of installation activities for the works.

4.7.5 **Spares Management Plan**

4.7.5.1 The Contractor shall submit for review by the Engineer a Spares Management Plan to furnish a priced manufacturer-recommended list of spare parts, necessary to support continuous operation of all such equipment for a minimum period of 24 months after the commencement of Revenue Operations.

4.7.5.2 The Contractor shall submit the Spares Management Plan by not less than 365 days prior to the issue of the Taking Over Certificate for the Works.

4.7.6 **Defects Liability Management Plan**

The Contractor shall submit for review by the Engineer a Defects Liability Management Plan to repair, replace and perform any remedial item upon the Works identified by the Engineer during Defects Notification Period (DNP). The first submission of this plan is required not less than 365 days prior to the issue of the Taking Over Certificate for the Works. The Contractor shall;

(1) endeavour to complete all necessary work in a timely responsible manner;
(2) not proceed with any remedial work without the consent of the Engineer;
(3) submit a plan that details the method and timing of any proposed work; and

End of Chapter-4

CHAPTER 5 – DOCUMENTATION REQUIREMENTS

5.1 General

5.1.1 During the life cycle of a project, the contractor has to produce different types of documents to facilitate the planning, tracking and reporting of the project. The documents range from feasibility studies, resource plans, financial plans and project plans, design documents, post-implementation reviews, change request forms and project status reports.

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

5.1.3 The Document shall be easily readable and understandable. No matter how significant the work may be, it is not of much use if the document cannot convince readers. The document shall be written in clear and concise English/ Hindi duly keeping in mind the document is issued to communicate with readers not the document preparer him/herself.

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

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

5.1.6 The Drawings to be prepared and CAD Standard to be followed shall be in accordance with Annexure-5.

5.2 Document Control Procedure

(1) Document Control - Within 28 days after Commencement Date, the Contractor shall submit the Document Control Procedure to the Engineer for review which shall include but not be limited to as mentioned below:

  (a) A document approval system which shall specify the level of authority for approval of all documents before submission to the Engineer and in accordance with the requirements as specified in Quality Assurance;
  (b) A system of issuing documents that shall ensure that pertinent documents are issued to all appropriate locations. The Contractor shall submit a submission programme. The submission program shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

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

  (a) Contract number;
  (b) Discipline;
  (c) Submission reference number; and
  (d) Revision history and status of the submissions.
  (e) Description of changes for each revision
  (f) The signatures of Contractor's preparer, reviewer and approver for authorization of the submission indicating proper design check has been carried out before submitting to the Engineer.

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

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

- Submission number.
- Submission title.
- Revision history.
- Status of Engineer's response for each revision.
- Submission dates and dates of return from the Engineer for each revision and
- Current status.

(4) Project records will eventually be used by the Employer to manage, operate and maintain the Works after the completion of the Contract under construction and for future reference.

(5) The Contractor shall submit the documents as required by the Engineer as project records in full and on time. The Engineer shall determine the adequacy of the project records.

(6) Each submission shall be made in 6 copies, if not specified otherwise. The Contractor may supply the additional copies for specific documents, on the request of the Engineer or to meet specific requirements if any of the PS.

(7) The submission not accompanied with full set of associated documents shall be considered incomplete.

5.3 Submission and Review Procedure

(1) Except where specific procedures are given for certain items, all submissions shall be submitted and reviewed according to the procedure laid down in the following clauses.

(2) Each submission shall be accompanied by a brief introduction to explain which subsystem - part of the Works to which the submission refers to, listing the documents enclosed with the submission and describing in outline how all relevant requirements of the Employer's Requirements are achieved by the proposals.

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

(a) Complies with all relevant clauses of the Employer's Requirements;
(b) Conforms to all interface requirements;
(c) Contains, or is based on auditable and proven or verified calculations or design criteria;
(d) Has been properly reviewed by the Contractor, according to the Contractor's Project Quality Assurance Plan, to confirm its completeness, accuracy, adequacy and validity;

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

(4) The Engineer's response to the submission will be made within 21 calendar days of receipt of the submission.

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

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

(7) If, in the Engineer's opinion, following receipt of a submission there is benefit to be gained from a meeting with the Contractor to clarify or discuss any of the contents of the submission, he will notify the Contractor accordingly with not less than 5 days advance notice, and the Contractor shall attend at the time and place appointed by the Engineer.

(8) In case of use of products / technologies, requiring evaluation and validation by RDSO/ISA as specified in relevant Particular Specifications Volume 2, the Engineer's response to the submissions by the Contractor will be made within 90 days from the date of submission of complete relevant data / certification by the Contractor.

5.4 Engineer's Response

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

(1) Notice of No Objection
(2) Notice of Objection with comment(s)
(3) Notice of No Objection with Comments

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

5.4.3 "Notice of Objection with Comment(s): if following his review of the submission the Engineer discovers major non-compliance, discrepancies or omissions etc . that in his opinion are of a critical nature, the Engineer will issue a "Notice of Objection" (NOO) with comment(s). The Contractor shall revise and resubmit the submission addressing the Engineer's comment(s). Following the issue of a NOO by the Engineer, the Contractor is not entitled to proceed to the next Programmed stage on the path in the relevant network as previously approved by

the Engineer until all of the Engineer's comments have been fully addressed and a NONO is issued.

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

End of Chapter-5

CHAPTER - 6 DESIGN REQUIREMENTS

6.1 General

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

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

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

6.2 Design Management

6.2.1 The Contractor shall establish an office for his dedicated design team in the Main Site Office of the Contractor at Allahabad and referred to as Design Team. The Design Team shall function from this office and all meetings and discussions relating to design shall be held in this office or in the office of Engineer/Employer and/or as instructed by the Engineer. In addition to the requirements detailed herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.

6.2.2 The members of the Design Team shall have the requisite experience and qualification appropriate to the type and magnitude of the design involved. Full details regarding their qualifications and experience shall be submitted to the Engineer for his consent

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

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

6.3 General Design Criteria

6.3.1 Design for individual equipment, system and works shall be as per Employer's Requirements, Part 2, Section VI.

6.3.2 The design shall be reliable, energy and cost efficient with due considerations to the local climate conditions, safety, ease of installation, operation, maintenance and future replacements.

6.3.3 **Durability and Maintenance**

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

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

6.3.4 **Operational Requirements**

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

(2) The system offered shall be safe and reliable as safety remains a primary concern for the railways. The methodology adopted for the design and installation of the facility shall be such as to ensure a smooth and accident free operation.

(3) As the railway systems are expected to live through potentially long life the system offered and installed shall be such as to be compatible with future expansion and technological upgrades without hassles.

(4) Since the time period for the completion of the project is limited, the system may be designed with a modular approach so that prefabricated and pre tested modules are easily installed at site.

(5) It is a requirement that the Indian Railway (IR) remains operational during the construction/Installation phase.

6.3.5 **Aesthetics**

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

6.3.6 **Human Factors**

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

6.3.7 **Safety, Health and Environment Considerations**

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

6.3.8 **Quality Control**

Quality control aspects shall be kept in mind during the Design, Manufacturing/Supply, Construction/ Installation and testing & commissioning phases, requirement for which has

been specified at appropriate places in the Bidding Document as well as in Chapter-11, Quality Assurance Requirements. It shall be the overall responsibility of the Contractor to ensure deliverables of quality products at all times conforming to the provisions mentioned in this bidding document.

6.4 Design Stages

6.4.1 The design of this project is divided into various stages as under:

(1) Preliminary Design

(2) Detailed Design

(3) Construction/ Installation Design

(4) As Built Documents

6.4.2 The Procedure for Design Submission is laid down as under

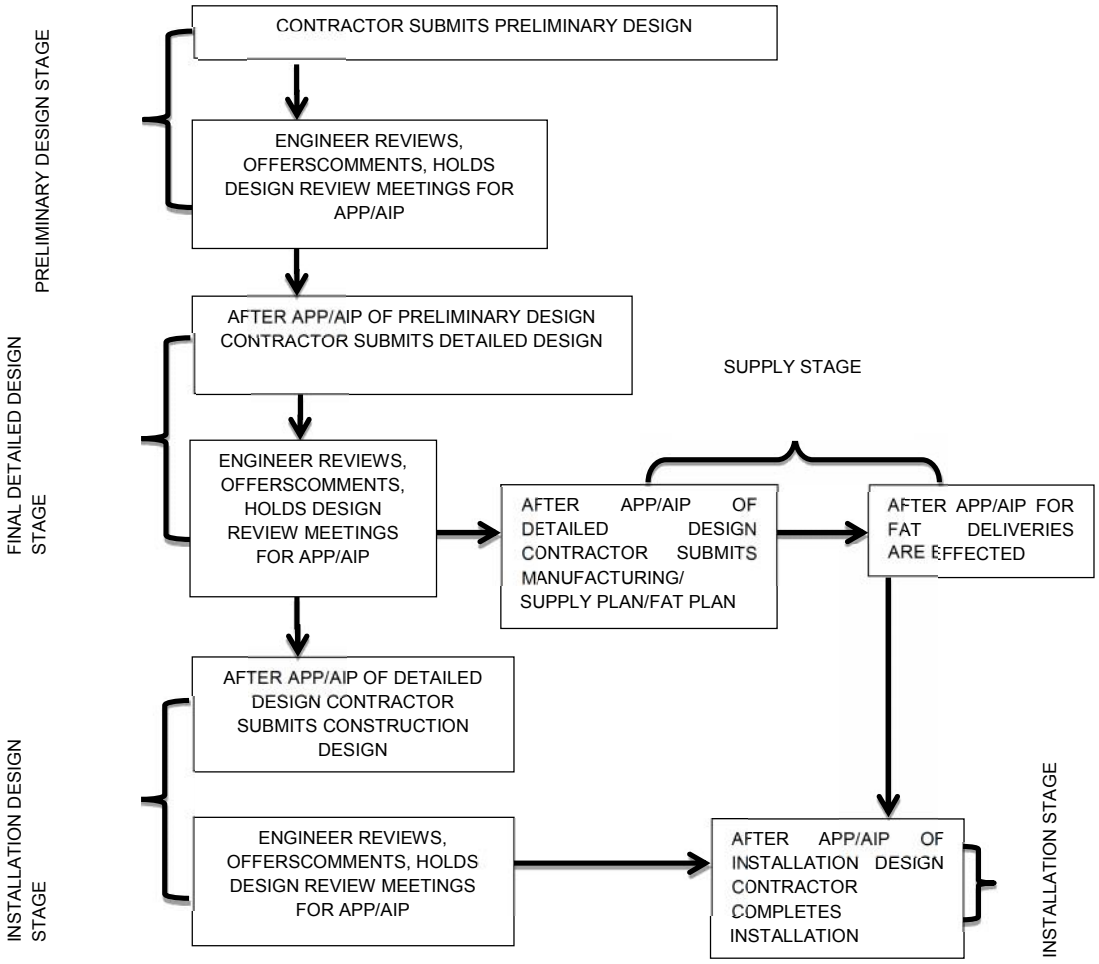


Figure 6.4: Procedure for Design Submission and Approval

6.5 Preliminary Design

6.5.1 Based on the Employer's Requirement, the Contractor shall prepare a System Requirement Specifications (SRS) which includes, as a minimum operational, functional, performance and design requirements of the proposed system.

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

6.5.3 The System Requirement Specifications (SRS) shall include a compliance matrix that includes cross-references to the requirements stated in the Particular Specifications, the System Requirement Specifications and the Design Verification Table (DVT).

6.5.4 The Preliminary design stage, as a minimum, shall identify the function of each system, sub-system, equipment or other element within the overall SRS and specify the relationships and interfaces between each element of the system including the systems of the interfacing elements of other Contractors. Equipment and interconnection specifications, with supporting calculations, shall be developed at this stage. Submissions shall clarify and confirm as necessary technical aspects of all interfaces with other elements of contractor's overall design and of any interfaces with systems of other contractors.

6.5.5 Ergonomic design, mock-ups/prototypes shall be developed during this stage.

6.5.6 The Contractor, during this phase, shall submit the Preliminary Design. Subsequent to the study conducted, the contractor shall develop his basic designs of the system and the sub-systems. The Safety of the entire Railway Network including the work to be done by other Contractor(s) for earthing and bonding shall be an important document to be prepared for approval by the Engineer. The Basic and detailed Design Report submission shall also provide details.

6.5.7 The Contractor shall review the indicative General Arrangement and other Drawings, wherever applicable and suggest modification(s) and improvements based on site conditions and as a result of the simulation exercise conducted by him and approved by the Engineer.

6.6 Calculations

6.6.1 Unless otherwise required by the Engineer, calculations shall be submitted together with the Preliminary Design Package submission.

6.6.2 A comprehensive set of calculations for the whole of the Preliminary Design, commencing from the input and output data to the Simulation Program (in the form acceptable to the Engineer) shall be submitted by the Contractor to the Engineer for consent as part of the relevant submittals.

6.6.3 Should the design of the Works be revised thereafter and such revision(s) render the submitted calculations superseded, then the Contractor shall prepare and submit revised calculations and the revised design simultaneously.

6.6.4 The Engineer shall require the Contractor to submit and install one copy of all the applicable software as used by the Contractor for the Design, including the Simulation Computer Program duly licensed in the name of Employer and also in-house Software Program/ Worksheets developed by the Contractor, computer input and program logic prior to the

acceptance of any computer output. The Contractor shall submit the same to the Engineer without any additional cost.

6.6.5 The Contractor shall submit all calculations necessary to support proposals relating to the construction/Installation methods.

6.7 Detailed Design

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

- All standards and regulations have been identified and applied;
- Calculation and analysis are complete;
- All main and other significant elements are delineated;
- All protocol of tests and trials, all selection of material and equipment are complete;
- Full account of the effect on the Project Works of the proposed methods of Installation, Testing & Commissioning and of the Temporary Works has been taken into account; and
- Complete the validation of all the data provided by the Employer including all the additional surveys, investigations and testing as considered necessary by the Contractor to develop the Detailed Design of the Works in accordance with the Contract.

6.7.2 The Detailed Design shall be based on the Preliminary Design developed to the stage at which all sub systems of the Works are fully designed and specified.

6.7.3 The Designs shall be submitted within the specified period as per the Design Submission Program consented by the Engineer.

6.7.4 The Detailed Design shall include the Technical Drawings, the Works Specifications, the Detailed Design Report and all other contents of the Detailed Design Submittals.

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

6.7.6 The Contractor shall demonstrate, to the satisfaction of the Engineer, the adequacy of the ratings of the equipment and conductors and their suitability entailing all load, permanent and temporary, and also its effects on other Contracts.

6.7.7 Upon completion of Internal Authorization Process as specified in Chapter 11 - Quality Assurance, the Contractor shall submit the Detailed Design as described herein, Requirements for Design, to the Engineer for consent and issue of a "Notice of No Objection".

6.8 Construction/Installation Design

6.8.1 Upon the issue of a Notice of "No Objection" in respect of a Detailed Design Submission, the Contractor shall produce the respective Construction/Installation Design Submission which shall include, but not limited to,

(1) The Technical Drawings,

(2) The updated Works Specifications including Method Statements/ work procedures/ construction/Installation sequences,

(a) The Construction Sequence Statement: The document illustrates the sequence of one cycle of particular construction implementation in which such sequence is critical to maintain the quality, safety and/or any other important factors of the construction implementation.

(b) The Safety Risk Assessment: The analysis describes and evaluates the risks associated with the construction implementation anticipated in the course of the construction.

(3) The Working Drawings:

(a) The Site Drawings: these are supplementary detail drawings which expand and explain the information shown on the Construction Technical Drawings based on the site conditions and dimensions existing there.;

(b) The Fabrication Drawings: These are supplementary drawings of specific elements of the works such as for the switchyards, portal structures shown on the Construction Technical Drawings for the purpose of manufacture or fabrication of those element and erection.

(c) All other drawings as deemed necessary by the contractor for the accurate and safe construction of the Works in accordance with the Contract.

6.8.2 Technical Drawings, updated Works Specifications/ Method Statements etc. shall be derived directly from the Detailed Design as approved by the Engineer including changes that may be necessary to resolve the comments of the Engineer attached to the Notice of No Objection.

6.8.3 The Working Drawings and the Construction/Installation Practicing Documents shall be prepared to facilitate construction/Installation to meet the required workmanship as well as technical requirements. The Works Management Plans shall be prepared to check and monitor the Works in terms of SHE requirements described in Chapter-11 - Quality Assurance.

6.8.4 Upon receipt of the “Notice of No Objection” or “Notice of No Objection with Comments”, the Contractor shall endorse the original paper drawings in respect of the Working Drawings as “Good For Construction/Installation” as per the Internal Authorization Process as defined in the Design Quality Assurance Plan detailed in Chapter 11 - Quality Assurance. If the Engineer so requires, the said endorsed original paper drawings shall be re-submitted to the Engineer, who shall, if he has no objection to the contents of the re-submission, further endorse the original paper drawings by stating that he has no objection to the proposed Working Drawings. On endorsement by the Engineer, the original drawings will forthwith be returned to the Contractor as Working Drawings to be issued to the Site.

6.8.5 Technical Drawings and the Working Drawings shall be used for construction/Installation purposes and only those drawings and documents that have been endorsed and certified through the procedure and have received “Notice of No Objection” as above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site.

6.8.6 The Construction/Installation of the Works shall be strictly in accordance with the Construction/Installation Design Submission for which “Notice of No Objection” has been

issued by the Engineer and "Good For Construction/Installation" drawings has been issued as per the authorization process detailed as above.

6.8.7 The Construction/Installation Design may be divided into multiple submissions for different Work Segments, in such a case,

(1) Construction/Installation Design and Drawings in respect of each subsystem in a Work Segment shall be submitted for the entire subsytem

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

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

6.8.9 The Construction/Installation Design submission shall be a coherent and complete set of documents in line with the Detailed Design which has received "Notice of No Objection" from the Engineer and shall fully describe the proposed Construction/ Installation Design.

6.9 As-Built Documents

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

6.9.2 The As-Built Drawings shall be a full set of the latest revisions of the Preliminary/ Final Detailed/Construction/Installation Designs and Drawings (updated to incorporate all Design Change Notices and Field Change Notices) and as many Working Drawings as necessary to convey a full and true record of the as-built condition of the Works. The As-Built Drawings shall show all changes from the Preliminary/ Final Detailed/ Installation Design and all other features relevant to the future maintenance and management of the DFCC and its facilities. The As-Built Drawings shall be endorsed by the Contractor as true records of the construction/Installation of the Works.

6.9.3 Configuration data tables shall be prepared for each individual sub-system on item by item basis as well as on location basis.

6.9.4 The As-Built Documents shall also incorporate the changes to dimension and details from the Construction Drawings and changes due to variation orders.

6.9.5 Following shall also be part of the all As-Built Documents :

(1) Official letters regarding the design change acceptance;

(2) Certificates of acceptance between the Contractor and the Engineer;

(3) A construction diary;

(4) Design Certificate as detailed in Annexure-4.

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

(1) The implemented work according to activities, places and price

(2) Used Material – type, name of manufacturers along with batch number, place and price etc.

(3) Any other record as required by the Engineer.

6.9.7 The O&M Manuals for Signalling and Telecommunication systems/subsystems shall be considered part of the As Built drawings and documents.

6.9.8 The As-Built Documents shall be submitted to the Engineer for consent and issue of a "Notice of No Objection" at no extra cost to the Employer.

6.10 Contractor's Coordination with others

6.10.1 The Contractor shall fully coordinate the design of the Works with the design of other contractors and shall follow the interfacing requirements as stipulated in Chapter-10 - Interface Requirement.

6.10.2 Those Works, which are required to be executed by the other contractors, shall be fully coordinated and integrated throughout the Detailed Design development and the results shall be recorded and summarized in the Combined Service Drawings (CSD) and the Interface Report on other contractors as part of the Detailed Design and the Construction/Installation Design.

6.10.3 Coordination with External Related Parties: The Contractor shall fully coordinate the design of the works with all relevant bodies and entities, in particular government authorities, departments and regulatory bodies, public utility companies, Power Supply Authorities adjacent Indian Railway Authorities and the consultants and contractors of adjacent projects whether ongoing or planned, as advised by the Engineer. The Contractor shall identify all such related parties in his Interface Management Plan (IMP) and other relevant requirements as detailed in Chapter-10, Interface Requirement.

6.10.4 Co-ordination with Indian Railways:

(1) For some S&T Works proposed by Contractor and having implication over working of Indian Railways and its Systems, approval from Indian Railways through the Employer shall be required, in addition to the consent by the Engineer. The Contractor shall be required to submit three additional copies of such Preliminary Design & Detailed Design to the Engineer for onward submission to Indian Railways.

(2) The Contractor shall co-ordinate in seeking the approval from Indian Railways, however, the Employer shall facilitate the Contractor in seeking the approval from Indian Railways including, but not limited to, providing clarifications / additional data, attending meetings etc. as required.

(3) It will be the Contractor's responsibility to take approval of Indian Railways on the designs, however the Employer will extend all assistance in seeking these approvals.

6.11 Contractor's Warranty of Design

6.11.1 The Contractor shall give warranty that the design produced by them (in accordance with the Conditions of Contract) meets the Employer's Requirements and Specifications provided by the Employer and is fit for the purpose thereof. In accordance with Chapter-11- Quality Assurance & Annexure-4 – Design Certificates. Where, there is any inadequacy, insufficiency, impracticality or unsuitability from the Employer's Requirements and Specifications or any part thereof, the Contractor's design shall take into account, address or rectify such inadequacy, insufficiency, impracticality or unsuitability at Contractor's own cost.

6.11.2 The Contractor shall indemnify the Employer against any damage, expense, liability, loss or claim, which the Employer might incur, sustain or be subject to arising from any breach of the Contractor's design responsibility and/or warranty set out in this clause.

6.11.3 The Contractor shall further specify and shall deemed to have checked and accepted full responsibility for the Contractor's part of the design (in accordance with Conditions of Contract) notwithstanding.

(1) That such design may be or have been prepared, developed or issued by the Employer which has been checked by the Contractor, any of Contractor's consultants, his sub contractor's and/or his qualified personnel/persons or cause to be prepared, developed or issued by others.
(2) Any warranties, guaranties and/or indemnities that may be or may have been submitted by any other person.
(3) That the same have been accepted by the Engineer.

6.11.4 The Contractor shall conform to the provision of any statute relating to the Works and regulation and bye-laws of any local authority and of any water and lighting agencies or undertakings with whose system the work is proposed to be connected and shall before making any variation from the drawings or the specifications that may be necessitated by so confirming give to the Engineer notice specifying the variation proposed to be made and the reason for making the variation and shall not carry out such variation until he has received instructions from the Engineer in respect thereof. The Contractor shall be bound to give all notices required by statute, regulations or bye-laws as aforesaid and shall pay all fees and taxes payable to any authority in respect thereof. Nothing shall be payable by the Employer in this regard.

6.11.5 The Contractor shall ensure compliance of provision of all laws of land in force and enacted from time to time and:

(1) Ensure compliance of the regulations or bye-laws of any local body and utilities.
(2) The Contractor shall arrange necessary clearances and approvals before the work is taken up. Nothing extra will be paid by Employer on this account.
(3) Ignorance of rules, regulations and bye-laws shall not constitute a basis for any claim at any stage of work.

6.11.6 The Design Warranty shall be submitted by the Contractor as per the format detailed in Annexure-4 –Design Certificate.

6.12 Design Changes

6.12.1 If there is a requirement to change the design after the Construction Design has been submitted and consented by the issue of Notice of No Objection during the Construction Phase, the Contractor shall propose, the design change through either a Field Change Notice (FCN) or a Design Change Notice (DCN).

6.12.2 These design changes shall go through the full process of the Design Review Procedure as described in this Chapter and Chapter-11 - Quality Assurance.

End of Chapter-6

CHAPTER 7 - SUPPLY, INSTALLATION, TESTING AND COMMISSIONING

7.1 General

7.1.1 The Contractor shall establish procedures and controls that govern the procurement/manufacturing off-site of material/equipment/ components required for the work and supply them for construction/installation assembling and wiring in the Permanent Works.

7.1.2 The Contractor shall establish Comprehensive Test and Inspection instructions for procurement/manufacturing, packaging, marking, shipping, handling, storage and preservation, to protect the quality of the material/equipment/components and to prevent damage, loss, deterioration, degradation or substitution thereof.

7.2 Procurement/Manufacturing

7.2.1 The Contractor shall ensure that all the material required for the work is manufactured/procured, inspected, tested and delivered as per the specifications and guidelines specified in the Employer's requirements.

7.2.2 In order to ensure quality in procurement/manufacturing, the Contractor shall

(1) Make a Procurement Management Plan, comprising of the details on Procurement, Manufacturing and Delivery in respect of all items and goods;

(2) Detailed Method statements for various activities such as Purchasing, Manufacturing, Inspection etc.

(3) Prepare a Material Delivery Plan;

(4) Develop and maintain a Material Control Schedule;

7.2.3 **Manufacturing inspection and test provisions**

(1) All the material procured/manufactured shall be inspected and tested.

(2) The Contractor shall propose a structured set of inspection hold points. The hold points shall be structured such that a formal hold point is allowed for each significant element of the manufacturing process.

(3) At each hold point, the Employer's Personnel shall hold a formal inspection or advise that the inspection has been waived.

(4) In order to facilitate such an inspection, the detailed production/manufacturing plan shall be provided by the Contractor to the participants of the inspection, at least six weeks in advance of the commencement of the manufacturing process along with the description of mandatory specifications and tests proposed during the manufacturing process and the tests intended to be conducted on the finished product along with codal permitted tolerances.

(5) Once the inspection and any required remedial actions are completed to the satisfaction of the Employer's Personnel, the Employer's Personnel may give a notice of no objection to the results of Inspection as jointly witnessed. The Engineer will not

withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has been successfully completed.

7.2.4 The material delivered at the Site and offered for Inspection shall be manufactured normally not earlier than one (1) year and their guarantee period shall cover the Defects Notification Period.

7.3 Packaging, Shipping, Storage and Delivery

7.3.1 **Packaging and Shipping**

(1) The packaging and shipping of the equipment shall be designed and implemented to minimise damage whilst in transit.

(2) Each case, crate or package shall be of robust construction and suitable for the intended purpose. Packaging material that are likely to suffer deterioration in quality as a result of exposure to environmental conditions likely to be met during transit from the factory of origin to the Site shall not be used.

(3) The contents of each case, crate or package shall be protected against the harmful effects of ingress of moisture / water by enclosing within a heavy duty waterproof membrane.

(4) Each case, crate or package shall be legibly and indelibly marked in large letters with the address, Contract number, 'right way up', opening points and other markings like "fragile", "keep dry", "handle with care" etc along with visual display of internationally accepted symbols as necessary to permit material to be readily identified and handled during transit and when received at Site.

(5) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents together with any relevant drawings. Second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the requirements of the Engineer.

(6) All items shall be marked on the outside of the case to show the gross and net weights, the points for slinging and where the weight is bearing.

(7) Care shall be taken to prevent movement of equipment within containers by the provision of bracing, straps and securing bolts as necessary.

(8) Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped.

(9) Details of cases, crates, packages, containers, etc., intended to hold important or delicate items of equipment or material shall be submitted to the Engineer for acceptance.

(10) Sub-Assemblies:

All components shall be packed together and properly labeled and numbered. Diagrams to ensure that they are properly assembled at site in the required order of components shall also accompany the packaging.

(11) Spare parts shall be suitably packed for storage over an indefinite period without deterioration and shall be clearly identified showing full name and part number without any need to unwrap packaging. Electrical and other delicate items or equipment shall

be cocooned.

(12) Cable ends, cable entry points into equipment and other similar terminations and openings shall be sealed or blanked off to prevent the ingress of dirt, vermin or moisture.

(13) Tube ends and other similar openings shall be thoroughly cleaned and then blanked-off to prevent ingress of dirt or moisture.

(14) Flanged ends shall be protected by adhesive tape or jointing material covered by a properly secured wooden blank not smaller than the flange itself.

(15) Particular care shall be taken to prevent damage to or corrosion of shafts and journals, where they rest on timber or other supports that may contain moisture.

(16) At such points wrappings impregnated with anti-rusting compositions shall be used, of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

(17) Care shall be taken to minimize risk of damage to ball and roller bearings and any fragile material in transit.

(18) The Contractor shall ensure satisfactory completion of manufacturing and testing check prior to shipment.

(19) All shipments shall be adequately protected to preclude damage during shipment. The Contractor's quality control personnel shall verify the inspection and preparation for shipment.

(20) The Handling procedures shall include the use of special crates, boxes, containers, transportation vehicles, equipment and facilities for material handling.

7.3.2 **Cable Drums**

(1) Immediately after the tests at the place of manufacturing, both ends of every length of cables shall be sealed by enclosing them with approved caps, tight fitting and adequately secured to prevent ingress of moisture.

(2) The ends of the factory lengths of cable shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers is clockwise and "Z" the end at which the sequence is anti-clockwise.

(3) The end which is left projecting from the drum shall be consistently "A" or "Z", and shall be protected against damage in such a manner that the enclosure cannot be easily removed during handling while in transit.

(4) Cables shall be supplied on drums in the longest possible lengths and within practical limits.

(5) The maximum allowable diameter of cable drum shall be 2000 mm. The use of cable drums with diameter in excess of 2000 mm shall be subjected to the review of the Engineer.

(6) The drums shall also be designed for use in conjunction with any special cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

(7) Each drum shall bear a distinguishing number and label "DFCCIL", either printed or neatly chiselled on the outside of a flange.

(8) Particulars of the cable, i.e. voltage, length, conductor size, number of cores, section

and length, gross and net weights, shall be clearly shown on one flange of the drum. In addition the words "Running End 'A'" or "Running End 'Z'" as appropriate shall be marked on the flange and the direction for rolling shall be indicated by an arrow.

(9) An arrow showing direction of rolling shall be shown. Both ends of the cables shall have heat shrinkable caps. The caps shall incorporate sealants which melt on heating at temperatures well above outdoor ambient expected in DFCC area.

7.4 Storage and Delivery

(1) Unless otherwise consented by the Engineer, the Contractor shall provide adequate storage facilities by way of covered areas at his own cost for storing in a safe and secure manner all the plant & equipment and manufactured items to be supplied and erected as part of the Contract.

(2) The Contractor shall make its own arrangement of space for storage facility. However, if the spare land is available with the Employer, the same will be handed over to the Contractor free of cost, for the purpose of establishing temporary construction depot(s) with the condition that whenever the Employer requires this portion of land back, the same shall be handed over by the contractor at a month's notice and no extra cost/compensation to the Contractor.

(3) Means shall be provided by the Contractor for protection against deterioration or damage to equipment in storage. Where shelf-life of the equipment / material is limited, this shall be clearly stated on the shipment. Secure compound and storage for the high value items shall be integral part of the safe storage. Spares to be supplied, shall also be kept safe and secure until handed over to the Employer at the time of Commissioning.

7.5 Construction/Installation

(1) The Installation shall be carried out by competent and skilled staff. The Contractor shall ensure that his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

(2) The Installation shall be carried out with necessary and sufficient resources such as tools, test instruments, spares, equipment, manpower and communication facilities.

(3) During installation, every precaution shall be taken to protect the existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment.

(4) All the Installation works shall be supervised to ensure that and technical, safety and quality matters adhere to the Design as reviewed by the Engineer.

(5) The Installation shall be done in accordance with the approved Installation Plan and Method Statements. All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Engineer.

(6) The Installation Method Statements shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.

(7) Prior to proceeding with installation, the Contractor shall submit, for the Engineer's

consent, six copies of drawings showing all installations including dimensions, supports, hardware, installation methods and documents confirming the availability and location of special installation tools and equipment and all other pertinent data.

(8) During installation, care may be taken to ensure that the manufacturer's erection instructions are correctly followed.

(9) The installation for major items such as important components and vital equipment of Signalling & Telecommunication Equipment shall be undertaken preferably in the presence of the manufacturer's field service representative.

(10) The Contractor shall make certain that the installation of all supports, gaskets, hardware, etc., are accomplished so as to assure safe, accurate and trouble-free installation.

(11) Upon noticing or being advised of any inconsistencies between the installation drawings and documentation and the installed equipment, the Contractor shall notify his acknowledgement to the Engineer and correct such errors within two weeks.

(12) Equipment that is improperly installed shall be removed, checked / tested and reinstalled. Any damage caused due to improper installation and removal shall be rectified before reinstallation at no extra cost to the Employer.

7.5.1 Asset Identification

(1) The Contractor shall submit an asset database for review by the Engineer. The database shall contain the complete asset listing for all aspects of the contract works.

(2) The database shall provide the following information, but not limited to:

(a) Asset Details;
(b) Date Manufactured
(c) Date Installed; and
(d) Date(s) Tested.
(e) Failure History

(3) All equipment and software shall have a unique identification number that can be identified electronically and manually.

7.6 Testing and Commissioning

7.6.1 General

(1) The Contractor shall provide and perform all forms of testing procedures applicable to the Works relating to plant & equipment and manufactured items and various components and the interfacing of the Works relating to plant & equipment and manufactured items with the other contractor(s) and shall conduct all necessary factory, site and acceptance tests.

(2) The commissioning activity shall include a period of the Integrated System testing followed by a period of Trial Run.

(3) Within 6 months from the date of Commencement of the Work, the Contractor shall submit a comprehensive Testing Program defining the personnel, procedure and format of testing.

(4) All testing procedures shall be submitted at least twenty eight (28) days prior to conducting any Test. The testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the acceptance criteria, the relevant drawing (or modification) status and the location.

(5) The testing procedures shall be submitted by the Contractor and amended subsequently, if required, by the Contractor during the duration of the contract to reflect changes in design of works, interface systems or the identification of additional testing requirements, if needed.

(6) The contractor shall facilitate the Employer's Personnel to monitor all tests and have access to all testing records.

(7) Sufficient time shall be allowed within the Testing Programs for necessary alterations to equipment, sub-systems and designs to be undertaken, together with re-testing prior to final commissioning.

(8) The Contractor shall keep in mind that at some point of time, the electric Traction System shall be energized and the additional precautions for the safety and co-ordination of the activities prior to and after 'power-on' shall be anticipated in his co-ordination with other contractors and installation, testing and commissioning Programs of all the contractors and all associated with the Traction Power Energisation Program.

(9) All costs associated with the testing shall be borne by the Contractor. This shall include the Inspection/Testing Charges to be paid to RDSO/RITES/Test Laboratories. The Contractor shall also bear any expense incurred due to resetting/retesting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

(10) The cost incurred by Engineer and/or Employer's Personnel against hotel and travel expenses for witnessing of testing shall not be borne by Contractor.

(11) In the event of any test being performed in the countries other than India, the Contractor shall give at least 56 days' notice to the Engineer for witnessing the test. The Contractor shall not be required to bear the cost of the Employer's Personnel visit i.e. travel expenses, boarding/lodging etc.

(12) Unless agreed to in writing by the Engineer, the personnel engaged on testing shall be independent of those directly engaged in the design or installation of the same equipment.

(13) All testing equipment shall carry an appropriate and valid calibration labels. They shall be periodically checked for calibration accuracy.

(14) All reports of the tests shall be signed by the Contractor's Representative.

7.6.2 Testing Philosophy

(1) Testing of various items shall be carried out as per the Testing procedures approved by the Engineer. An appropriate format for Test Schedule(s) and Procedure(s) including the details of testing equipment shall be submitted to the Engineer for approval.

(2) Unless otherwise agreed, all Tests shall be witnessed and signed by the authorized representative of the Engineer & recorded. Attendance on Tests, including that by Engineer / Employer, and the Contractor shall be as laid down in the Quality Assurance procedures detailed in Chapter-11 of this GS.

(3) All tools & instruments for carrying out the tests shall be arranged by the Contractor to the satisfaction of the Engineer. .

(4) Prior to shipment of equipment, the Employer's Personnel reserves the right to witness the testing of the equipment at the manufacturers' works.

7.6.3 **Sequence of Tests**

The sequence of tests shall generally comprise of the following:

(1) Type Tests, as and when required;

(2) Factory Acceptance Tests (FAT);

(3) Installation Tests;

(4) System / Sub-system Acceptance Tests (SAT);

(5) Integrated Testing & Commissioning; and

(6) Trial Run.

The details on each type of tests have been covered in the respective PS (Signalling) and PS (Telecommunications).

7.6.4 **Samples for Testing**

(1) Samples that have been tested may be utilized in the Works provided that:

(a) The sample complies with the specified requirements;

(b) The sample is not damaged;

(c) The sample is not required to be retained under any other provision of the Contract; and

(d) Consent of the Engineer has been obtained, in writing.

(2) Additional samples shall be provided for testing, if in the opinion of the Engineer:

(a) Material previously tested no longer complies with the specified requirements; or

(b) Material has been handled or stored in such a manner that it may not comply with the specified requirements.

7.6.5 **Test Certificates and Reports**

(1) The Contractor shall submit manufacturer's type and routine test certificates and reports for each equipment and device. Complete test results are to be submitted in clearly identified and organized booklet, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures. Test reports shall also include the Quality Assurance Certification, the standards to which the equipment comply, and the standards to which the equipment was tested.

(2) The Contractor shall submit to the Engineer for review, not less than six (6) months before testing and commissioning activities commence, his proposed format for the testing and commissioning records. The records shall be appropriately sub-divided to make provision for the various parts of the Permanent Works covered by the Contract.

(3) The format of the records shall cover all tests, including tests to be conducted after modification of the design/installation based on DCN/FCN.

(4) The Contractor shall, during the execution of the Works, prepare such reports and record of design, manufacture, installation and testing, as may be required, in order that a license can be issued or statutory requirements can be met or approval given. Such reports or records shall be adequate to enable each part of the Permanent Works to be commissioned and to meet the requirements of the licensing authority or any standing statutory regulations and shall be reviewed by the Engineer.

(5) The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Engineer. If the Employer or the Engineer has witnessed the inspection or test, he may countersign the inspection or test report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein) If the Employer or the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or the Employer or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Employer/ the Engineer may call for a re-inspection or re-test.

(6) At the end of each inspection/test or group of tests, the Contractor shall obtain report which shows the result of all the inspections and/or tests carried out. If required by the Engineer, a manuscript copy of the test record shall be made at the time of the test and given to the Engineer or at the earliest opportunity if the test has not been witnessed.

(7) The contractor shall carry out an analysis of the results and certify that the work has been inspected and/or tested in accordance with the requirements of the Contract and that the work complies with the requirements of the Contract.

(8) The Authorized representative of the Contractor, who has been assigned the required authority under the relevant quality plan, shall sign each report of inspection and/or test.

(9) In addition to any other requirements, the report shall contain but not limited to, the following details:

(a) Material or part of the Works tested;

(b) Location of the batch from which the samples were taken or location of the part of the Works;

(c) Place of testing;

(d) Date and time of tests;

(e) Weather conditions in the case of in-situ tests;

(f) Technical personnel supervising or carrying out the tests or inspection;

(g) Size and description of samples and specimens;

(h) Method of sampling;

(i) Number and types of tests which are required to be done.

(j) Specified acceptance criteria;

(k) Tests actually carried out.

(l) Method of testing or inspection;

(m) Properties tested or inspected;

(n) Test results, including any calculations and graphs;

(o) Results actually achieved

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

(q) All relevant checklists and work sheets used during the inspection and/or test , including readings and measurements taken during the tests; and

(r) Other details stated in the Contract.

(10) After Commissioning of a part of the Works, the Contractor shall complete each commissioning record in the agreed format and shall forward copies of the record to the Engineer for review

End of Chapter-7

CHAPTER 8 – WORK AREA MANAGEMENT

8.1 Works Area

8.1.1 The Contractor shall divide the Site into separate Works Areas and shall elaborate a schedule for the time periods of the availability of these areas for his contract performance. This should be synchronized with the Schedule of access to Site provided in the Bidding documents taking account of the Contractor's co-ordination and integration responsibilities with the interfacing contractors.

8.1.2 The Contractor shall indicate the exact nature of the various Works Areas and the extent of works to be carried out prior to the execution of the permanent systems works or making use of the area as working space and/or for temporary Site facilities.

8.1.3 The schedule as mentioned above shall include, but not limited to, the following data:

(1) Indication of the Works Areas;

(2) Description and intended use of the Works Areas;

(3) The start and the end date of the availability of the Works Areas, required by the Contractor;

(4) The start and the end date of the periods in which the Contractor is to allow the Works Areas to be accessed by interfacing parties.

8.1.4 The information shall be submitted as part of the Contractor's preliminary design and shall be subject to agreement by the Employer and approval by the Engineer.

8.1.5 On the basis of the approved information, the Contractor shall submit the proposal for the use and the occupation of the Works Areas, such submissions being at least fifty six (56) days prior to the program use of the specific Works Area.

8.1.6 Prior to the scheduled dates for returning of any of the Works Areas for subsequent use by an Interfacing party, the Contractor shall carry out the following activities:

(1) Construct all Permanent Works within the Works Area, to the extent as defined in the Detailed Design and in accordance with the requirements of the Contract;

(2) Reinstate the area to the same condition as it was taken over;

(3) Form the area to the approved lines and levels and carry out such other works as may be required by the provisions of the Contract;

(4) Remove all rubbish, debris and other material; and

(5) Carry out and record jointly with the Engineer and interfacing contractors a condition survey of the area.

8.1.7 Restrictions on the timing of occupation so as to avoid affecting operation will be made.

8.1.8 The Interfacing parties shall be required to vacate the Works Areas at least 56 days before the due date for handing over back of the Works Areas by the Contractor to the Employer, thus allowing the Contractor to clear and reinstate the works areas in accordance with the Contract.

8.1.9 Entry to and exit from the Site shall be controlled and shall be only available at the locations for which the Engineer has given his consent.

8.1.10 The Contractor shall ensure that access to every portion of the Site is continually available to the Employer and Engineer.

8.1.11 Other contractors engaged for project execution shall also be allowed to use the temporary facilities so created by him to access the Site without any consideration.

8.1.12 The Employer will take over the entire stretch as per General Conditions of Contract.

8.1.13 The Contractor shall be responsible for ensuring that any access or egress through the Site boundaries are controlled such that no disturbance to residents or damage to public or private property takes place as a result of use of such access or egress by its employees and sub-contractors.

8.2 Standard Engineering Conditions

The following standard engineering conditions apply to all Works Areas:

8.2.1 Forming of Areas

(1) The Works Areas shall be formed to the levels shown on the drawings.

(2) No levels shall be amended without prior consent of the Engineer.

(3) The Works Areas shall be surfaced in a manner agreed with the Engineer, compatible with their intended use and in particular, footpaths and roadways connecting facilities shall be provided.

(4) Measures shall be taken to the satisfaction of the Engineer to ensure all areas are properly drained and kept free of static water.

8.2.2 Roads and Parking

(1) Space shall be provided within the Works Areas for parking, loading/unloading and manoeuvring of motor vehicles.

(2) Any damage caused by the Contractor to the adjoining public roads and fixtures and properties (public or private) shall be made good to the satisfaction of the Engineer and its owner.

8.2.3 Drainage and Sewerage

(1) All storm or rainwater from the Work Areas including any access roads thereto shall be carried to the nearest stream course, which has the necessary capacity, catch-pit, and channel or storm water.

(2) All temporary and permanent Works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the Site and adjacent property.

(3) Damage or obstruction caused to any watercourse, drain, main or other water installations within or adjoining the Works Areas shall be made good to the satisfaction of the Engineer.

(4) Treatment and disposal of sewage and wastewater from the Works Area shall be provided to the satisfaction of the Engineer following the ecological requirements.

8.2.4 Buildings

(1) No permanent structures other than those required for the Permanent Works shall be permitted in the Works Areas.

(2) The Contractor, as required, for all temporary buildings, shall provide requisite electricity, water, telephone and sewerage facilities.

8.2.5 Pedestrian Access

(1) Any accesses or passing through the Works Areas shall be maintained in a usable condition at all times to the satisfaction of the Engineer including lighting, signing and guarding.

8.2.6 Fencing and Signboards

(1) For executing the work adjacent to running traffic areas, the Contractor shall erect fences and gates around its areas of operations to prevent accidents as well as post competent flagmen.

8.3 Possession Management

8.3.1 General

(1) The Contractor shall comply with the traffic block (Possession) management system operated by Indian Railways (IR).

(2) The Contractor shall appoint a responsible person who shall coordinate with IR and with the CST Contractor, who will act as the traffic block coordinator.

(3) The person appointed must have experience of IR operations and must be fully aware of IR rules and regulations related to possession of track for construction of railway works and in accordance with IR regulations to issue possession requests.

(4) For the purpose, he shall be duly certified in accordance with the said rules.

8.3.2 Possession Periods

(1) The Contractor may use possession(s) on the line for execution of works as per approved plan following strict safety procedures.

(2) Line closures may be agreed subject to IR approval.

(3) The Employer gives no warranty that line closures and possession periods will be available during the period of the Works.

(4) The Employer will however provide any assistance necessary to the Contractor to enable him to obtain the line closures and possessions required by him for the Works but will not be responsible if any Possession requests are refused by IR.

(5) The Contractor shall prepare technological and organizational schedule for construction which shall include the work times in the weekends and during the dark part of the day.

(6) The Contractor shall submit his requests for ‘possessions’ at least fourteen (14) days earlier and inform IR at least 48 hours earlier if he is not able to use the permitted ‘possessions’.

8.4 Construction-Precautions

8.4.1 Precautions While Working In Close Proximity of Existing Indian Railway Track

(1) General

(a) Prior to the commencement of construction operations, the Contractor shall obtain all necessary clearance(s) from the concerned authorities.

(b) Any construction activity involving the existing embankment/formation/ running track of the Indian Railways shall be carried out only with the prior specific authorization of the Engineer.

(2) Works being executed outside running lines are further divided into following 3 sub groups depending upon their distance from the IR track:-

(a) Works being done within 3.5 meters from centre of track.

(b) Works being done between 3.5 meters and 6 meters from centre of track

(c) Works being done beyond 6 meters from centre of track

If a work site is located far away from the existing track but the vehicles in connection with the work are required to ply within the distance from center of track as mentioned above, it will be construed that the work in being executed under above classification.

(3) Works being done within 3.5 meters from centre of track

All works planned within 3.5 meters from centre of running line or which involve working of machineries and vehicles within this zone, are to be done essentially under block protection and necessary safety precautions for protection of track as per para 806 and 807 of IRPWM shall be taken. This includes even occasional plying of vehicles/ machineries for short durations.

(4) Works being done between 3.5 meters and 6 meters from centre of track

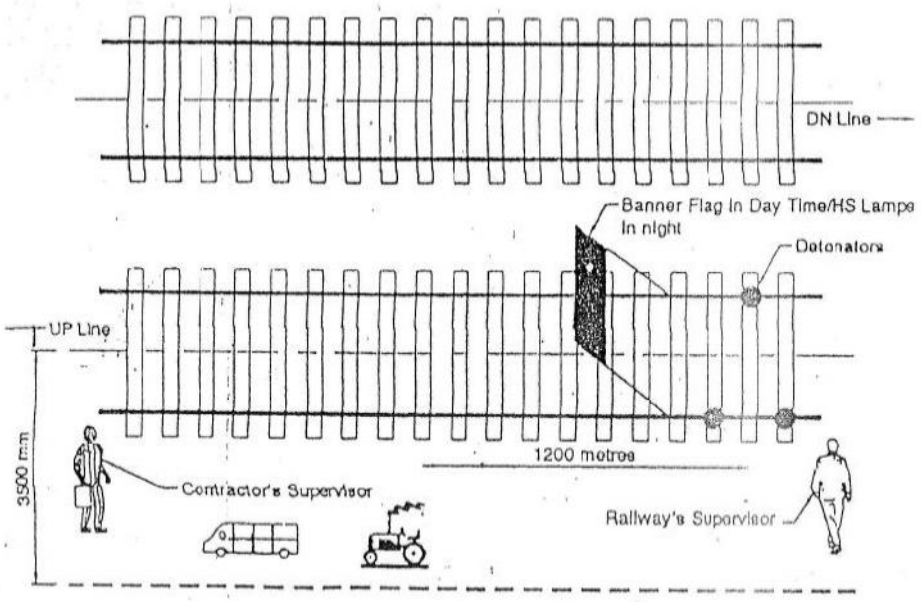
Following precautions shall be taken when works are required to be done between 3.5 meters to 6 meters from track centre or machines/vehicles are required to work/ply within this zone.

(a) Before start of work, demarcation should be done parallel to running track at a distance of 3.5 meters from centre of track in advance, as per sketch B, by 150 mm wide white line of lime. Any work or movement of machinery infringing this line will need block protection. Barricading should be put up at such locations, as per sketch C, to ensure that even by carelessness or over sight, vehicles do not infringe fixed dimensions. Barricading design shall be approved by the Engineer.

SAFTY/PROTECTION ARRANGEMENT SKETCHES

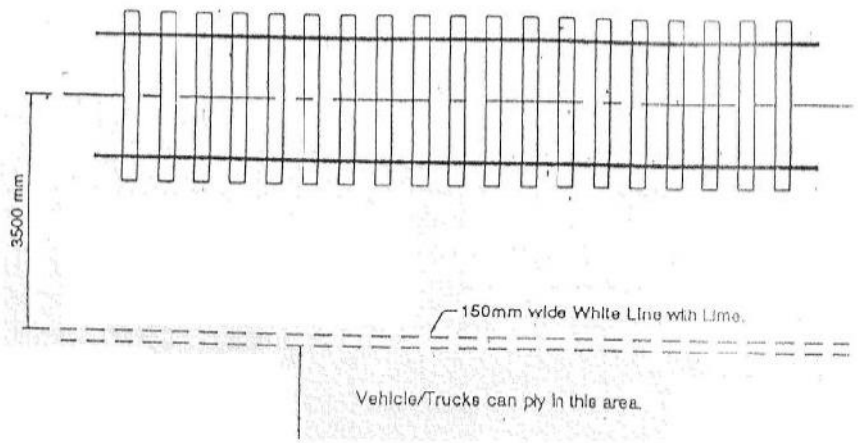
SKETCH - A

Plying of Vehicles/Machinery within 3.5 Mts. from centre of track.



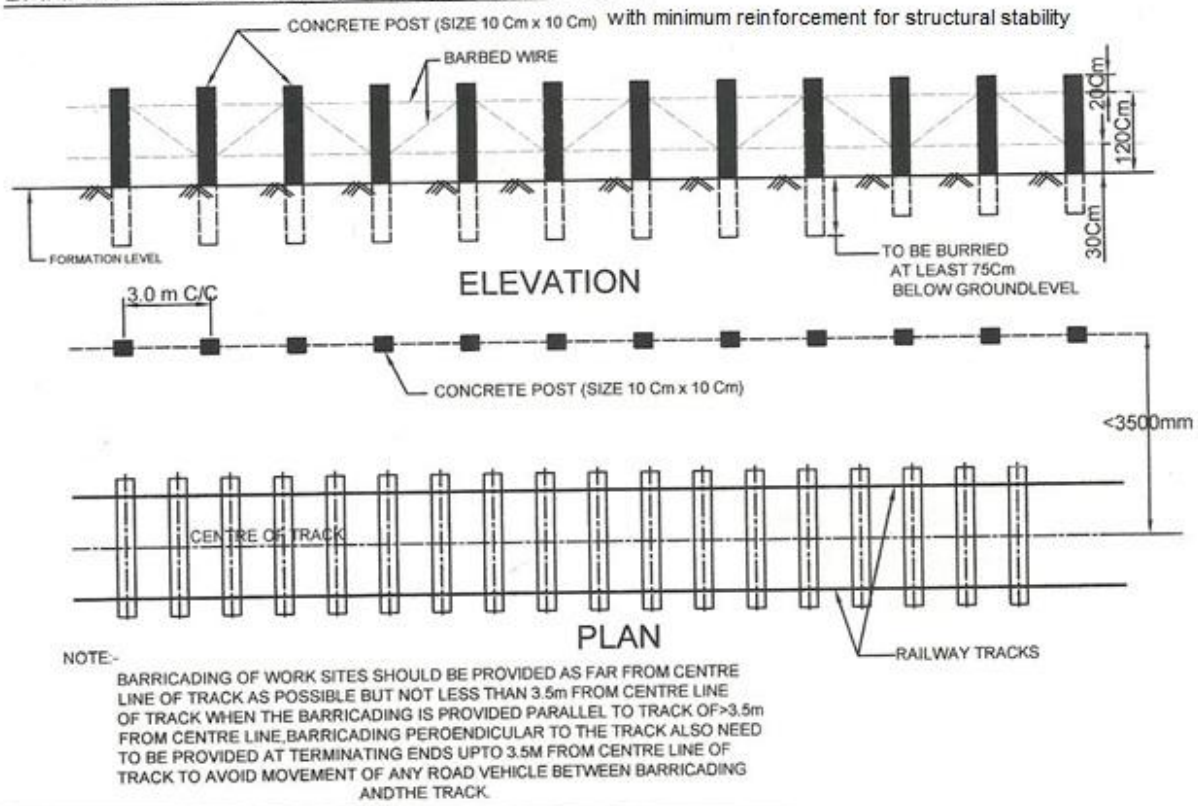
SKETCH - B

Marking of White Line with Lime.



SKETCH - C

BARRICADING FOR SAFTEY AT WORK SITE

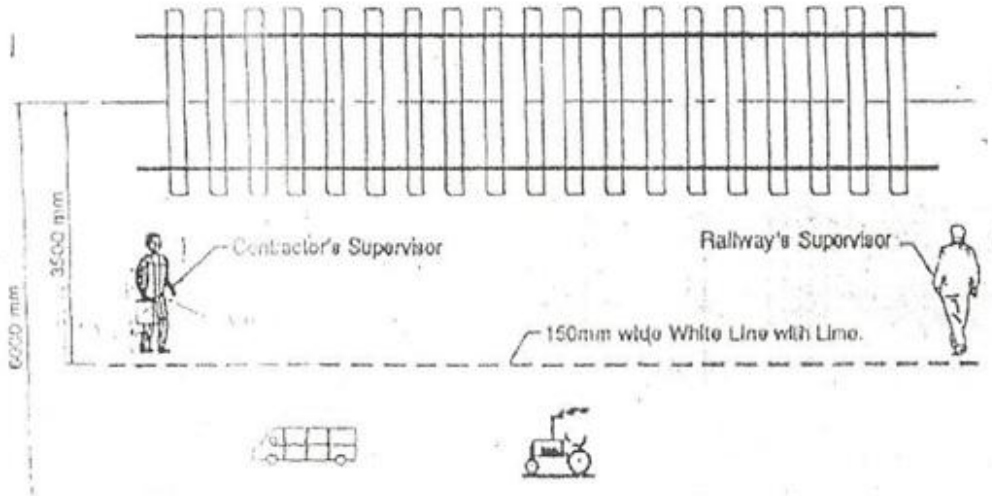


NOTE:-

BARRICADING OF WORK SITES SHOULD BE PROVIDED AS FAR FROM CENTRE LINE OF TRACK AS POSSIBLE BUT NOT LESS THAN 3.5m FROM CENTRE LINE OF TRACK WHEN THE BARRICADING IS PROVIDED PARALLEL TO TRACK OF>3.5m FROM CENTRE LINE,BARRICADING PEROENDICULAR TO THE TRACK ALSO NEED TO BE PROVIDED AT TERMINATING ENDS UPTO 3.5M FROM CENTRE LINE OF TRACK TO AVOID MOVEMENT OF ANY ROAD VEHICLE BETWEEN BARRICADING ANDTHE TRACK.

SKETCH - D

Plying of Vehicles/Machinery between 3.5 Mts. to 6.0 Mts. from centre of track.



(b) In case vehicles have to ply or machineries have to work within this zone, railway's and contractor's supervisors be positioned as shown in sketch D except for the following:

(c) Instead of a Railway supervisor it would be a responsible and trained staff of the Contractor as mentioned in para (b) above.

(d) Additional trained staff of the Contractor, as mentioned in para (b) above, shall be posted where turning of vehicles is required during working. Location for reversing vehicles should be nominated and it should be selected in such away that there is no danger to running trains at such a location. Such trained staff of the Contractor should be available with hand flag(s) so that vehicles do not come closer to track by 3.5 meters. Wherever vehicles have to take turn, it should be done in such a way that the driver is invariably facing the running track at all times.

(e) Look out men should be posted along the track at a distance of 800 meters from location of work with red flag and to whistle in face of road vehicles and approaching trains. Look out men shall also be suitably trained staff of Contractor as mentioned in para (b) above.

(f) In addition to look out men, caution order needs to be issued to trains and speed restrictions imposed wherever considered necessary through Employer.

(g) Arrangements should be made to protect the track in case of emergency at work site.

(h) All temporary arrangements required during execution should be done in a manner that moving dimension is not infringed.

(i) Individual vehicle/machinery shall not be left unattended at site of work. If it is unavoidable and essential to stable it near running track, it shall be properly secured and manned even during non working hours with all arrangements to protect the track from infringement.

(j) Any material unloaded or shifted along the track should be kept clear of moving dimensions and stacked at a specified distance from running track.

(k) Movement of vehicle/working of machineries should be prohibited at night. However, in case of emergency when night working is unavoidable, adequate lighting shall be provided with all protection measures as mentioned above in full force. All night working near IR track shall require Engineer's prior approval.

(l) The work site should be suitably demarcated to keep public and passengers away. Necessary signages, boards, such as "work in progress" etc should be provided at appropriate location to warn public/passengers.

(m) Contractor's drivers/operators handling vehicles/machineries shall be issued a fitness certificate by the safety officer of the Contractor after educating them about safety norms and after taking assurance in writing for working within vicinity of railway's track.

(n) While working on cuttings with machineries or when there is movement of vehicles above cutting, if there is possibility of any of the following circumstances, work has to be done under block protection:

- Any possibility exists for machinery/vehicle after toppling/due to loss of control come over track or infringe it.
- Chance of machineries/vehicles to come within 3.5 meters from track centre though working beyond it.

(5) Works being done beyond 6 meters from centre of IR track.

No special precautions are needed except in cuttings or where the work can affect train running in any way.

8.5 Utilities

8.5.1 All the chartered and unchartered utilities along the track alignment have been/is being removed/relocated by the Employer/Other Contractor(s). Land within ROW free from all encumbrances including structures shall be available to the Contractor for execution of Works under this Contract.

8.5.2 In case the Engineer decides that the work of removal of any unchartered utility to be done by the Contractor, this shall be treated as a Variation to the Contract and shall be dealt as per the provisions for dealing with Variations in Contract. The Contractor shall be paid as per actual work done for removal of uncharted utilities based on the Variation approved by the Engineer, on case to case basis.

8.6 Procedure for Removal of Trees

8.6.1 Cutting/Removal of trees have/shall been/be done by the Employer/Other Contractor(s) and the land within ROW free from all trees shall be handed over to the Contractor.

8.6.2 If for the purpose of the Works under this Contract, additional tree(s) are required to be cut or removed, the Contractor must notify the Engineer of the same. Engineer shall in turn advise Employer for cutting or removal of such tree(s).

8.6.3 If for the purpose of the Works under this Contract, trees are required to be trimmed, the same shall be trimmed by Contractor at no extra cost.

8.7 Temporary Works

8.7.1 All necessary Temporary Works required for the realization of the works such as Temporary Facilities and Temporary Utility Services including labour camps shall be provided & maintained by the Contractor for his own use, for his sub-contractors, the Engineer and the Employer unless otherwise authorized by the Engineer.

8.7.2 The Temporary facilities including, but not limited to, Warehouses, material stock areas fencing of Works sites as well as the Temporary Utilities services including, but not limited to, Power Supply, lighting, water shall be provided, equipped & maintained in good working conditions until the issues of taking over certificates.

8.7.3 The Contractor shall take adequate precautions in the provision and the maintenance of the Temporary Power Supply to Temporary Works and to Works areas.

8.7.4 The Contractor shall ensure that Temporary Works shall be constructed/installed, and maintained duly following provisions of SHE Manual of DFCCIL.

8.7.5 Temporary Works shall be dismantled and removed by Contractor after construction/installation, at his own cost. The Engineer, however, may permit retention of some of the Temporary Works with mutual consent between the Contractor and the Engineer.

End of Chapter-8

CHAPTER 9 – SAFETY, HEALTH AND ENVIRONMENTAL REQUIREMENTS

9.1 General

9.1.1 DFCC has prepared its own Safety, Health and Environment (SHE) Manual which is attached in Reference Documents – Part 4 of Bidding Documents. This SHE Manual shall be applicable on the Works being carried out under this Contract. Various penalties as stipulated in the said manual shall be applicable under this Contract for violation of relevant stipulations.

9.2 Contractor's Responsibility for Safety

9.2.1 The Contractor shall comply with all safety and industrial health legislation including, without limitation to the rules and regulation of the National Safety Council of India.

9.2.2 The Contractor shall develop its own Safety and Health procedures and systems in line with SHE Manual of DFCCIL and in compliance to applicable acts and legislations.

9.2.3 The Contractor shall, within sixty (60) days of the Commencement Date, prepare and submit to the Engineer for review his proposed Safety, Health & Environment Management Plan.

9.2.4 The Contractor is required to develop systems and procedures for ensuring compliance with all the precautions required for the safety of the workmen.

9.2.5 The Contractor shall produce a policy statement signed by the Managing Director of the Contractor or other senior officer acceptable to the Engineer, or the Managing Directors or other senior officers acceptable to the Engineer of each company of the consortium, partnership or joint venture comprising the Contractor,

(1) Declaring that the safety and industrial health will be given priority consideration in all aspects of the Works and by the Contractor in discharging his contractual obligations;
(2) Reflecting an understanding of and means of ensuring due compliance with the statutory regulations and standards relating to construction work in India;
(3) Indicating the statutory and contractual obligations regarding safety, rescue and industrial health imposed on the Contractor and the means by which the Contractor will supervise, monitor and audit his site safety assurance system to ensure due compliance with these obligations.

9.2.6 The Contractor must comply with all regulation regarding scaffolding, ladders, working platform, excavation, etc. as per SHE manual of DFCCIL.

9.3 Appointment, Duties and Responsibilities of Safety Staff

9.3.1 The safety staff and organizational structure should identify the personnel to be, engaged solely for site safety assurance.

9.3.2 Names, addresses, telephone, email and fax numbers of all participants shall be listed where known (supplements to the site safety plan will update and complete this information);

9.3.3 The powers vested in the safety staff shall be sufficient to enable them to take urgent and appropriate action to make safe the site and prevent unsafe working practices or other infringements of the safety plan or statutory regulations.

9.4 Site Safety Inspections

9.4.1 The Contractor shall conduct Site safety inspections at a regular frequency. The findings of the inspections shall be recorded on suitable forms which shall be kept available for inspection by the Engineer.

9.5 Policy for Identifying Hazards

9.5.1 The means the Contractor will use to identify hazards, assess the risks and develop procedures and method statements to minimize the risk for those risks which will occur during the works shall be elaborated

9.5.2 The Contractor shall produce a list of safety and health hazards identified for this Contract and the procedures and method statements for achieving effective and efficient minimization of the risks associated with such hazards.

9.6 Safety Equipment

9.6.1 The Contractor shall produce policy and procedures for ensuring that all his plant and equipment used on the works site is maintained in a safe condition and is operated in a safe manner.

9.6.2 The Contractor must comply with all regulation regarding scaffolding, ladders, working platform, excavation, etc. as per SHE manual of DFCCIL.

9.6.3 The means by which safety equipment, scaffolds, guard-rails, working platforms, hoists, ladders and other means of access, lifting, lighting, signing and guarding equipment shall be inspected, tested and maintained and the standards below which such items will be removed from the site and replaced shall be elaborated.

9.7 Safety and Health Procedures

9.7.1 The contractor shall produce regulations and procedures covering all safety and health aspects of the Works, including where appropriate but not limited to the Housekeeping, Working on or near Operating Railways, Fire Prevention Precautions and Fire-Fighting Equipment, Working in Confined Spaces, Excavation, Hot Weather Working, Electrical Equipment, Welding/Cutting Operations and Equipment, Personal Protection Clothing and Equipment, Cranes, Hoists, Other Lifting Appliances, Manual Lifting, Ladders, Power Tools, Hand Tools and Portable Power Driven Tools, Hazardous Substances, Working at Height, Structural Steel Erection, Lighting and Protection against Falling Objects.

9.7.2 **Sub-Contractors**

(1) The Contractor shall identify and determine means by which safety, rescue and industrial health matters and requirements will be communicated to Sub-Contractors of all tiers and their due compliance with the Site Safety plan and all relevant statutory regulations.

(2) The Contractor shall determine method by which the safety procedures and practices proposed by sub-Contractors will be reviewed for compliance with the Site safety plan and statutory regulations including the provision of hazard and risk assessments and method statements

9.7.3 **Disciplinary Procedures**

The Contractor's disciplinary procedures with respect to dealing with safety related matters both with his own staff and that of sub-Contractors shall be given.

9.7.4 **Accident Reporting**

The Contractor's procedure for reporting and investigating accidents, dangerous occurrences or occupational illness both of his own staff and that of Sub-Contractors shall be given.

9.7.5 **Safety Promotion**

The Contractor shall provide details of the frequency, coverage and intent of site safety meetings together with the rationale for attendance.

9.7.6 **Site Security**

(1) The Contractor shall lay down a system for the protection of authorized and unauthorized visitors to the site;
(2) The Contractor shall ensure that construction methods do not compromise the Contractor's commitment to the Site safety plan or its compliance with the statutory regulations.

9.7.7 **Labour Safety**

(1) The activities of Contractor shall be co-ordinated with Indian Railways so as to ensure safety of all Contractor's personnel.
(2) Labour safety arrangements by the Contractor shall be in accordance with the applicable legislation in India.
(3) The design and construction shall comply with the applicable legislation in India.
(4) The Contractor shall provide the equipment needed for the labour safety..

9.7.8 **Legislation and Codes of Practice**

(1) The Contractor shall keep at site copies of safety and industrial health regulations and documents.
(2) All regulations and documents referred in this clause shall be translated into languages which are understood by the operators and supervisors engaged by the Contractor or sub-Contractors and such translations shall be displayed or kept alongside those in English language.

9.8 Site Safety Plan

The Contractor shall submit Site Safety Plan as part of Safety, Health and Environment Management Plan to the Engineer for review. This Site Safety Plan shall cover the following:

9.8.1 **Safety Personnel**

(1) The Contractor shall appoint a Safety officer whose duties throughout the period of the Contract shall be entirely connected with the safety and industrial health aspects of

the Contractor's activities on the site.

(2) The Safety officer shall be a suitably qualified and experienced person who shall supervise and monitor compliance with the site safety plan.

(3) The Safety officer shall, in particular but without limitation, carry out auditing of the operation of the site safety plan in accordance with a rolling program to be submitted, from time to time, to the Engineer for his consent.

(4) The Safety officer's appointment shall be within fifty six (56) days of the Commencement Date and shall be subject to the Engineer's written consent.

(5) The Contractor shall not undertake any works on the site until the safety officer has commenced duties at site and unless the Engineer has specifically consented in writing.

(6) The Contractor shall not remove the Safety officer from the site without the express permission of the Engineer. Within fourteen (14) days of any such removal or notice of intent of removal, the Contractor shall nominate a replacement safety officer for the Engineer's consent.

(7) The Contractor shall provide the Safety officer with supporting staff in accordance with the staffing levels set out in the site safety plan.

(8) The supporting staff shall include at least one Deputy Safety officer whose appointment(s) shall be subject to the Engineer's consent.

(9) The Deputy Safety officer(s) shall be capable of assuming the duties and functions of the safety officer as contained in the site safety plan whenever necessary.

(10) The Contractor shall ensure that the Safety officer maintains a daily site safety diary, such diary comprehensively recording all relevant matters concerning site safety, safety inspections and audits, safety related incidents and the like.

(11) The site safety diary shall be reviewed and signed on a weekly basis by the Contractor's site representative and shall be available at all times for inspection by the Engineer.

(12) The Contractor's staff organisation plan shall show direct lines of communication and reporting between the safety officer and the Contractor's site representative and between the safety officer and the person responsible for the Contract.

(13) The Contractor shall instruct and require the Contractor's site representative and the person responsible to be directly accountable in all matters concerning site safety.

9.8.2 **Safety / Accident Reporting**

(1) The Contractor shall submit regular site safety reports to the Engineer in accordance with the site safety plan.

(2) Such reports shall be submitted as part of the Monthly Progress Report. Prior to submission, the site safety report shall be endorsed by the Project Director responsible for the Contract and the Contractor's site representative.

(3) Site safety reports shall comprehensively address all relevant aspects of site safety and industrial health regulation and, in particular, report on all site safety audits undertaken during the period covered by the report.

(4) The Engineer shall be notified by the Contractor immediately of occurrence of any accidents whether on-site or off-site in which the Contractor, its personnel or plant, or those of its sub-Contractors are directly or indirectly involved and which results in any injuries to any persons, loss / damage to plant and machinery, disruption of traffic etc.

(5) Such initial notification may be verbal and shall be followed by a written

comprehensive report within 24 hours of the accident.

(6) Additionally the Contractor shall notify the Engineer in writing within twenty four (24) hours of any incident occurring whether on-site or off-site at which the Contractor or any sub-Contractors are involved and could have resulted in serious injuries to persons or significant damage to the Works. Failure to report such incidences shall be considered as a serious breach of Safety Procedures.

9.8.3 **Contractor's Instructions to Sub-Contractors**

(1) The Contractor shall provide its sub-Contractors with copies of the site safety plan and shall incorporate into all sub-contract documentation provisions to ensure the compliance with such plan at all tiers of the sub-contracting.

(2) The Contractor shall, with the Engineer's consent in writing, instruct all sub-Contractors to appoint a safety representative who shall be available on the site throughout the operational period of the respective sub-contract.

(3) These safety representatives shall ensure that all employees of sub-Contractors working at site are conversant with appropriate sections of the site safety plan and the statutory regulation.

9.8.4 **Safety Meetings**

(1) The Contractor shall convene regular safety meetings in accordance with the safety plan and shall ensure attendance by the safety officer and safety representatives of sub-Contractors unless otherwise agreed by the Engineer.

(2) All safety meetings shall be notified in advance to the Engineer who may attend in person or by representative at his discretion.

(3) The minutes of all safety meetings shall be taken and sent to the Engineer within seven (7) days of the meeting.

(4) A site safety management committee may be established by the Engineer to monitor the implementation of the safety plan and for the purposes set out in the project safety manual.

(5) The Engineer or his representative will be the Chairman of this committee and the members shall include the Contractor's agent or representative, safety manager and safety officers, sub-Contractors' safety personnel.

9.8.5 **Safety Equipment**

(1) The Contractor shall identify the safety equipment, rescue apparatus and protective clothing which will be required for the Works.

(2) The identification shall include the quantity, sourcing, standards of manufacture, storage provisions and means of ensuring proper utilization by all workmen and staff employed directly or indirectly by the Contractor and repair to or replacement of damaged equipment.

(3) The Contractor shall ensure that safety equipment and protective clothing as described in the safety plan is available and used on the site at all material times and those measures for the effective enforcement of proper utilization and necessary replacement of such equipment and clothing is incorporated into the site safety plan. Such equipment shall include, but not be limited to, site helmets, goggles and other eye protectors, hearing protectors, safety harnesses, safety equipment for working in

confined spaces (e.g. sewers, drains etc.), rescue equipment, equipment to rescue persons from drowning (if applicable), fire extinguishers, first aid equipment, and, where appropriate, suitable fall arrest equipment.

(4) The Contractor shall regularly inspect, test and maintain all safety equipment, scaffolds, guard-rails, working platforms, hoists, ladders and other means of access and egress, lifting, lighting, signage and guarding equipment.

(5) Lights and signs shall be kept clear of obstructions and legible to read.

(6) Equipment which is damaged, dirty, incorrectly positioned or not in working order shall be repaired or replaced immediately.

9.9 Safety Training

9.9.1 The Contractor shall conduct regular safety training and rescue training drills, the frequency, coverage and application of which shall be in accordance with the site safety plan and in any case shall not be more than every six months. Engineer may monitor the content of such training programs.

9.9.2 The Contractor shall require that all sub-Contractors' employees participate in relevant training courses appropriate to the nature, scale and duration of the sub-contract works.

9.9.3 The Contractor shall produce a description of the safety training courses that are to be provided. The syllabus, frequency, coverage and application of training courses shall be included together with the means of attaining the objective that all workmen shall be required to attend a safety induction course within their first week on site and thereafter at times appropriate to their prospective duties and at intervals of not more than six months. A summary of such training program conducted/ planned shall form part of Monthly Progress Report.

9.10 Breach of Safety Regulations

9.10.1 Any employees of the Contractor or sub-Contractor of any tiers who commit a serious breach of the safety regulations shall be liable to summary dismissal and shall not be re-employed on the Contract or allowed on any of the sites. This shall be prominently displayed on the site.

9.11 Interface with Indian Railway Operations

9.11.1 The Contractor will review the interfaces with Indian Railway's operations and prepare a specific safety plan for all works that may affect the operating railway.

9.11.2 The Contractor will comply with and incorporate Indian Railway's rules and regulations for track, signalling and operations possessions into his safety plan and will operate a permit to work system for all works which may affect the operations of the existing railway.

9.11.3 Similarly, the site safety plan shall consider with other interfacing contractors in the closed vicinity of the Employer.

9.12 Electrical Safety

9.12.1 Safety Requirements for Electrical Works

(1) The Indian Electricity Rules 1956 and Indian Electricity Act 2003 as amended up to

date, shall be followed. The detailed instructions on safety procedures given in I.S.S. and Indian Electricity Rules, respective State Electricity Authorities' regulation with up to date amendment shall be applicable.

(2) No flammable material shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act

(3) Protective and safety equipment such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus, safety goggles etc., shall be provided as per the requirement of the Work.

(4) Standard first aid boxes containing material as prescribed by the St. John's Ambulance Brigade or Indian Red Cross shall be made available.

(5) Charts displaying methods of giving artificial respiration to a recipient of electrical shock (one in English and another one in the regional language) shall be prominently displayed at appropriate places.

(6) No work shall be undertaken on live installations, or on installation, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary

(7) When working on or near live installations, suitable insulated tool should be used and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.

(8) The electrical switch controls in distribution boards shall be clearly marked to indicate the areas being controlled by them.

(9) All electrical panels & switchgear shall conform to relevant Standard.

(10) All external enclosures shall have degree of protection not less than IP-54

(11) All equipment/ sub-systems shall conform to relevant IEC standard on Electromagnetic Compatibility (EMC).

9.12.2 Standby Equipment

The Contractor shall provide adequate stand-by equipment to ensure the safety of personnel, the Works and the public.

9.12.3 Co-operation

The Contractor shall provide full co-operation and assistance in all safety surveillance carried out by the Engineer or the Employer. Any breaches of the site safety plan or the statutory regulations or others disregard for the safety of any persons may be the reason for the Engineer to exercise his authority to require the Contractor's site representative's removal from the site. Besides this Engineer may impose token penalty for such lapses as considered fit.

9.13 Health

The Contractor shall ensure that the provision of SHE Manual of the DFCCIL regarding occupational health & welfare are follow for workmen deployed under this Contract.

9.14 Environment Management Plan during Construction

9.14.1 The contractor shall take mitigation measures during pre-construction, construction and defect notification states against environmental impacts. Compliance of applicable statutory laws is essential, mitigation measures as described herein are to be adopted for land, water, air, noise, vibration and for protection of flora, fauna, health and safety issues.

9.14.2 The contractor shall develop his own Environment Management Plan (EMP), as part of the Contractor's Safety Health and Environment Plan (SHE) and submit to the Engineer for approval in accordance with the Environmental Impact Assessment (EIA) report and should meet the requirements of relevant Government of India Legislation like Pollution Control Board, various environmental; monitoring agencies of Government etc.

9.14.3 The project activities shall be executed in a phased manner, pre-construction phase, construction phase and operation phase. The major activities to be undertaken during construction phase are described below.

9.14.4 The environmental issues during construction phase generally involve quality, safety and public health issues. The Contractor required to comply with the laws with respect to environment protection, pollution control, forest conservation, safety and any other applicable laws. Environmental pollution control during the construction phase shall be the responsibility of the Contractor. EMP is an executable part of project and the activities are to be guided, controlled, monitored and managed as per the provisions provided.

End of Chapter-9

CHAPTER 10 –INTERFACE REQUIREMENTS

10.1 General

10.1.1 The Contractor shall co-ordinate its interface requirements with Employer and Other Interfacing Contractor(s), which Employer may engage from time to time, in such a manner so as to minimize disruption to any party arising from such concurrent work.

10.1.2 Co-ordination responsibilities of Contractor shall include, but not be limited to following:

(1) Provision of all information reasonably required by the interfacing parties in a timely and professional manner so as to allow them to proceed with their design or construction activities and enable them to meet their contractual obligations.

(2) Assurance that the interfacing parties' requirements are provided to all concerned interfacing parties in time providing them ample opportunity to do their part of requirement for interfacing.

(3) Receipt from interfacing parties of such information as is reasonably required to enable Contractor to meet design submission schedule as identified in Part 2, Employer's Requirement, Section VI, Volume 1, Chapter-6 – Design Requirements.

10.1.3 Assurance, copies of all the correspondence, drawings, minutes of meeting, programs, etc. relating to the Contractor's co-ordination with the interfacing parties shall be issued to all concerned parties and four (4) copies issued to the Engineer no later than seven (7) calendar days from the date of such correspondence and meetings.

10.1.4 The Contractor shall provide sufficient information for the Engineer to decide on any disagreement between Contractor and interfacing parties as to extent of services or information required to exchange. If such disagreement cannot be resolved by Contractor despite having taken all reasonable efforts, the decision of the Engineer shall be final and binding on the Contractor(s).

10.1.5 Where an interfacing contract is yet to be awarded, the Contractor shall proceed with co-ordination activities with Engineer until such time as interfacing contractor is appointed.

10.1.6 The Contractor shall note that information exchange is an iterative process requiring exchange and updating of information at earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the respective dates.

10.1.7 The Contractor shall co-ordinate with Engineer on all matters relating to works that may affect the IR operation on the existing railway. Such works shall be carried out in accordance with IR Rules and Regulations.

10.2 Interface Management Plan (IMP)

10.2.1 The Contractor shall be responsible for identifying all internal and external interfaces and shall develop and maintain a full interface management system which shall cover the functional and technical aspects of all the internal and external interfaces of the Contractor.

10.2.2 The Contractor shall prepare an IMP which shall identify the interface manager, the structure and responsibilities of interface management team and procedures that will be implemented to identify and close out all interfaces.

10.2.3 Interface Management Plan shall:

(1) Identify the sub-systems as well as works and facilities with interfacing

requirements.

(2) Define authority and responsibility of Contractor's and all other contractors' (and any relevant sub-contractors') staff involved in interface management and development.

(3) Identify information to be exchanged, precise division of responsibility between the Contractor and other contractor(s) and integrated tests to be performed at each phase of Contractor's and CST and other contractors' works.

(4) Address Works Program of Contract to meet milestones of each contractor and highlight any program risks requiring the Employer's attention keeping in view timeline of Contract.

(5) Address the interface issues during Design and Construction.

10.2.4 The Interface Management Plan shall include procedures for identifying and resolving interfaces within the Contractor's scope of work between the Contractor and the Employer and between the Contractor and other contractor(s).

10.2.5 The timescale for resolving interfaces shall be set down in Co-ordinated Interface Document (CIP) and with the each Other Interfacing Contractor(s).

10.2.6 **Design Interface**

(1) The Contractor shall commence the design interface with the interfacing contractor as soon as he has been notified by the Engineer that an interfacing contract has been awarded.

(2) The Contractor shall, immediately upon award of the Contract, gather all necessary information and develop his design to a level where meaningful interaction can take place.

(3) The Contractor shall submit together, with each of his design submissions a joint statement from Contractor and the relevant interfacing contractor confirming that design co-ordination has been completed and that they have jointly reviewed the appropriate document to ensure that a consistent design is being presented.

(4) The design interface is an iterative process requiring regular exchange and update of interfacing information and Contractor shall ensure that the information it requires from the interfacing parties is made known at the outset of each design interface so that the information can be provided in time for the Contractor and the interfacing parties to complete their design to meet their various design submission stages.

10.2.7 **Construction/Installation Interface**

(1) The Contractor shall ensure that there is no interference with the Works of the interfacing parties and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner.

(2) The Contractor shall carry out and complete the Works or part thereof, in such order as may be agreed by the Engineer or in such revised order as may be instructed by the Engineer from time to time.

10.2.8 **Employer's/Engineer's Input**

(1) The Engineer will coordinate the activities of the Contractor with reference to interfacing with other contractors and agencies during all the phases of the Contract.

(2) The Employer/Engineer, within the scope of the relevant Contract provisions, will support and assist the Contractor in the following fields:

(a) Interfacing with Indian Railways Authorities, State and local authorities for timely receipt of the required permits, certificates and approvals related to the design and construction process;

(b) Interfacing with State and local authorities for implementation of the additional land acquisition procedures;

(c) Any other fields of activities related to the Contract as may be required with the purpose of facilitating the Contractor's performance.

(3) This support and assistance of the Employer/Engineer shall not absolve the Contractor of any of his obligations under this Contract.

10.3 Interface Management

10.3.1 The Contractor shall create, in co-ordination with the other contractors, a Co-ordinated Interface Document (CID) for each interface, which shall be signed by all the parties involved.

10.3.2 An interface list shall be prepared and maintained by the Contractor and updated on a regular basis to reflect the actual needs of both parties.

10.3.3 The Contractor shall co-ordinate all interface items on the list and agreed solutions with the other contractors.

10.4 Dedicated Co-ordination Team

10.4.1 The Contractor shall establish a dedicated co-ordination team led by a coordinator reporting to the Contractor's Project Director.

10.4.2 The primary function of the team is to provide a vital link between the Contractor's design and manufacturing teams and the interfacing parties. The Contractor shall provide the Engineer with the particulars of the coordinator.

10.4.3 The Engineer shall have the right to direct the replacement of the coordinator if in his opinion the coordinator is unable to meet the co-ordination requirements of the Contract.

10.4.4 The Contractor's attention is drawn to the need for the coordinator to establish effective dialogues and communication links among the interfacing contractors. The Contractor's co-ordination team for interfacing shall comprise a mix of personnel with experience in both design and manufacture of equipment comprising the Works, necessary for effective co-ordination.

10.4.5 The coordinator shall assess the progress of co-ordination with interfacing contractors by establishing lines of communications and promoting regular exchange and updating of information so as to maintain the Contractor's program.

10.4.6 The complexity of the project and the importance of ensuring that work is executed within the stipulated time require detailed programming and monitoring of progress so that early program adjustments can be made in order to minimise the effects of potential delays.

10.4.7 The coordinator in conjunction with all interfacing contractors shall identify necessary provisions in the Works for plant, equipment and facilities of these contractors. These provisions shall be allowed by the Contractor in his design of the Works.

10.5 Coordination with other Contractors and Indian Railways

10.5.1 The Contractor shall undertake design co-ordination with other contractor(s) and Indian Railways.

10.5.2 The Contractor may commence design interfacing with other contractors and Indian Railways prior to the given period once information has been developed to a level where meaningful interaction can take place.

10.5.3 Design co-ordination shall include, but not be limited to, the following:

(1) Definition and agreement with other contractors of interface areas and contract limits;
(2) Definition and design approach by the Contractor with the other contractors and/or Indian Railways regarding environmental control requirements, system functionality requirements and control interfaces;
(3) Agreement of combined service drawings and structural opening drawings.

10.5.4 The Contractor shall liaise with the Engineer in developing a uniform identity code system which shall be used to uniquely identify each item of equipment and software component provided under this Contract and provided by the other contractors and/or Indian Railway.

10.5.5 Such identity codes shall be used for labelling each item of equipment and shall also be used in design reports, drawings and operations and maintenance manuals. Such codes shall comprise mnemonics for location names and equipment types as well as alpha-numeric for unique numbering.

10.5.6 The Contractor shall undertake Site activity co-ordination with the other contractors and/or Indian Railways within the periods stated for access and installation interfacing and co-ordination in the agreed CIP.

10.5.7 The Contractor shall undertake installation and testing in accordance with the milestones set in the Contract and the dates in the CIP and as agreed with the other contractors and/or Indian Railways.

10.5.8 The Contractor shall undertake a lead role in the co-ordination of the activities associated with integrated systems testing including the co-ordination of other contractors and/or Indian Railways to test and monitor their systems to prove the design and integrity of the systems as a whole.

10.5.9 It shall be the responsibility of the Contractor to secure from the other contractor(s) and/or Indian Railways, in a timely and correct manner as per the agreed CIP, whatever interface provision is required for the Contractor to carry out its duties under the Contract.

10.5.10 Any additional cost arising to the Contractor due to his late and/or improper interfacing with the other contractor(s) and/or Indian Railways, shall be to the Contractor's account. Such improper interfacing shall include, but not be limited to:

(1) Late provision of interfacing information
(2) Failure to adhere to agreed interface
(3) Changing an interface after it has already been agreed and signed off.

10.6 Signalling and Telecom Systems Interface Requirements

10.6.1 The Contractor shall coordinate with other contractors working in the section viz. CST Contractor(s) for Buildings & Structures and Track, the Electrical Contractor for E&M, Electrification and Power Supply, any other contractor engaged by Employer for Mughalsarai-New Bhaupur section. The Contractor shall also coordinate with Indian Railways officials, government departments etc., as required, for timely completion of the Work.

10.6.2 The Contractor shall associate with Electrical Contractor (CP-204) for the preparation of the Project wide EMC/EMI Management Plan, Bonding and Earthing Management Plan and Systems Integration Plan. The Contractor shall assess the risks and shall be responsible for their inclusion in the 'Interface Management Plan (IMP)' and 'Interface Coordination Document (ICD)' to be prepared by the Contractor.

10.6.3 The Contractor shall ensure that the issues/information pertaining to them that have been included in the IMP and the ICD, are timely exchanged/resolved and have no bearing on the Works Programme.

10.6.4 It would be the responsibility of the Contractor to settle all disagreements with the Other Contractor(s). If such disagreement cannot be resolved by the Contractor, despite having made all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

10.6.5 **Interface with Civil Structures and Track(CST) Contractor(s)**

The Contractor shall have to exchange information with CST Contractor(s) for the following, but shall not be limited to:

(1) Regarding track alignment, cant, versine, track geometry, rail levels, gradient, curve details, track center along with transition curve details.

(2) Right of Way and Access free of encumbrances to sites on Main Line and at Stations.

(3) HDPE/GI Pipes below tracks of requisite size for track-crossing of Signalling & Telecom Cables.

(4) The S&T requirement of Track, Track Alignment, Points & Crossings, Service Buildings, Yard Layouts etc., including the access dates and various milestone dates so as to co-ordinate the S&T Works under this Contract.

(5) All the information regarding S&T design and execution, which may be reasonably needed by CST Contractor(s) to design and execute their works under their Contract.

(6) Contractor's Interface with CST Contractor(s) shall, but not be limited to the following:

S.No.	Interface Subject	Contractor	CST Contractor	Document
1	Design and Construction of Signalling Equipment Room (SER), Telecom Equipment Room (TER) and S&T Power Supply Equipment Room(s) as part of Station Building at Stations.	1. Shall provide the requirement of ventilation and flooring. 2. Shall provide the requirement of cable ducts in the floor & cable-entry locations in the rooms. 3. Shall advise the size and location of cable pits being constructed at cable inlet points.	1. Shall design and construct the rooms.	
2	Design and Construction of additional Signalling structures in Station area	1. Shall decide the location for construction of any additional Signaling structures in Station area in coordination with the CST contractor. 2. Shall construct these additional Signalling structures in Station area.	1. Shall incorporate this requirement in relevant drawings.	Approved Site Plans for the SER/Power Supply Rooms.
3	Design and Construction of Telecom Equipment Room (TER) and Telecom Power Supply Equipment Room(s) at IMDs, IMSDs, and Staff Residential Colonies.	1. Shall provide the requirement of ventilation and flooring. 2. Shall provide the requirement of cable ducts in the floor & cable-entry locations in the rooms. 3. Shall advise the size and location of cable pits being constructed at cable inlet points.	1. Shall design and construct the rooms.	
4	Signalling Equipment Room (SER), Telecom Equipment Room (TER) and S&T Power Supply Equipment Room(s) in Block Sections and at Interfacing IR Stations.	1. Shall decide the location (Site Plans) for construction of SER, TER and Power Supply Equipment rooms in coordination with the CST Contractor. 2. Shall construct these SER, TER and Power Supply Equipment rooms.	1. Shall incorporate this requirement in relevant drawings.	Approved Site Plans for the SER/TER/Power Supply Rooms.
5	Radio Towers at Stations	1. Shall provide requirement of the	1. Shall incorporate this	

	and in Block Sections.	location and space for Radio Towers. 2. Shall construct the Radio Towers.	requirement in relevant drawings.	
6	Trenching for trackside cable laying.	1. Shall decide the route of cable trenching in coordination with the CST contractor. 2. Shall carryout trenching for trackside cable laying.	1. Shall provide route for trenches as required by S&T for their cable laying. 2. Shall provide drawings for any underground services laid by him.	Cable Route Plan
7	Track Alignment and Yard Plans	Shall advise modifications to yard plans if required from Signalling point of view duly approved by Engineer.	Shall modify the yard plans as per Signalling requirement duly approved by Engineer.	CST Contractor shall incorporate modifications in yard plans and shall process for their validation.
8	Cable passage requirement on bridges/culverts	Shall draw out sketches and provide to CST Contractor for requirement of cable laying on bridges/Culverts	Shall provide space for laying GI pipes/ Troughs on bridges, and shall provide Cable Ducts on Culverts.	S&T Contractor shall provide drawings showing requirements for cable running on bridges/culverts.
9	Point Machines installation	Shall coordinate with CST contractor for installation of Point and Point fittings as required by Signalling for Point machine installation and commissioning.	Shall provide Points and Point fittings as required by Signalling for point machine installation and commissioning.	Indian Railways Signal Engineering Manual
10	Testing of Points	Shall jointly test Points with CST Contractor during integrated testing & commissioning and rectify all Signalling defects as required during testing.	Shall jointly test the Points with S&T Contractor and rectify any track-related defects identified during testing	
11	Electrical Parameters of track/ turn-out related	Shall furnish the requirements of electrical parameters of track assembly	Shall provide the track parameters including, but not	

	assemblies	for track circuit (if provided)	limited to Ballast resistance, sleeper insulation etc., as required by S&T.	
12	Glued joints for Track Circuits (if provided)	Shall furnish requirement and locations of Glued Joints/Insulated Joints (if any)	Shall provide Glued Joints /Insulated Joints at locations specified by S&T (if any)	
13	Track/Road/Platform crossing of cables.	1. Shall decide the Track/Road/Platform crossing route, required for S&T work, in coordination with the CST contractor. 2. Shall carryout these Track/Road/Platform crossing.	1. Shall provide route for Track/Road/Platform crossings of S&T Cables, as per their requirement. 2. Shall advise location of RCC pipes as laid by them for S&T cable crossings.	
14	Marking centre-line of track and locations of stock joints.	Line-side installations shall be carried out in coordination with the CST Contractor.	Shall provide the centre-line and Stock-Joint locations.	
15	Centre-lines of Road and rail tracks at level crossings	Shall Install lifting barriers and road signals at the proposed level crossings as per the markings given by CST Contractor	Shall provide firm markings of rail tracks and road centre lines to the S&T Contractor. Shall provide Road Sign Boards.	A jointly signed drawing showing the centre-lines of rail tracks and the road with respect to a permanent land mark.

10.6.6 **Interface with Traction Electrification and E&M Contractor (CP-204)**

The Contractor shall interface with Traction Electrification and E&M Contractor (CP-204) to;

(1) provide information to Contractor CP-204, on Signals Locations/Implantation, Locations of S&T Equipment Rooms and requirement of Power for S&T installations in EDFC Phase-2, specifying the dates by which the E&M installations and their energisation is required.

(2) Provide space for installation of 'Change-Over' Switches at S&T Service Buildings.

(3) obtain information from Traction Electrification and E&M Contractor (CP-204), about the OHE Mast Plan, HT Cables and EMI/EMC Study carried out by him.

(4) Exchange information about the type, size and location of VDU Wall Panel at the OCC.

(5) Exchange information and interface on EMI/EMC studies carried out by Contractor and by Traction Electrification and E&M Contractor (CP-204), to decide upon and mitigate ill-effects of Electro-Magnetic Interference on Signalling & Telecommunication installations.

(6) Contractor's Interface with Traction Electrification, E&M Contractor (CP-204) Contractor(s) shall, but not limited to the following:

Item No.	Item Description	Signalling & Telecom Contractor	Traction Electrification, E&M and associated Works Contractor (CP -204)	Reference Document if any
1.	Signals on Insulated Overlaps	Shall locate Signals taking into account location of insulated overlaps	Shall share information on location of insulated overlaps.	
2.	Signals for Neutral Section	1. Shall share the location of Signals for determination of layout of Neutral section. 2. Shall adjust location of Signals as per layout of Neutral section.	1. Shall share Layout Plan of Neutral section for determination of Location of Signals. 2. Shall adjust Layout of Neutral section as per the Location of Signals.	1. Signal Interlocking Plan 2. Layout Plan for Neutral section
3.	EMI/EMC interface Signalling & Telecom cable details	1. Shall perform the EMC simulation study for S&T system, prepare EMC/EMI Management Plan identify needs & measures and implementation thereof. 2. Shall coordinate with other contractors and collect all the information as required for EMC/ EMI study	1. Shall perform the EMC simulation study for Traction, prepare EMC/EMI Management Plan identify needs & measures and implementation thereof. 2. Shall coordinate with S&T and collect information as required for EMC/EMI study 3. Shall share the information about HT Cables and OHE	
4	Bonding and Earthing Plan	Shall Design the Bonding and Earthing Plan in coordination with the Electrical Bonding and Earthing Plan.	Shall Design the Bonding and Earthing Plan in coordination with the Earthing and Bonding Plan of S&T	
5	OHE mast locations	1. Shall prepare the Signalling	Shall prepare Layout Plans of	Signal Interlocking Plan

Item No.	Item Description	Signalling & Telecom Contractor	Traction Electrification, E&M and associated Works Contractor (CP -204)	Reference Document if any
		Plan in coordination with OHE Layout Plan.	OHE in coordination with Signalling plan showing mast locations, wire staggers etc., including extra mast implantation needed if any for the Signal.	OHE Layout Plan
6	LT Power Supply, E&M and associated work including Fire Detection & Alarm System for S&T installations at Stations, IMDs and IMSDs.	1. Shall provide information of S&T Equipment load requirement at Stations, IMDs and IMSDs. 2. Shall advise the requirement of Electrical fittings including Lights, Fans, Sockets, Air-Conditioner etc. in S&T Structures at Stations, IMDs and IMSDs.	1. Shall design and provide LT power supply to S&T system at Stations, IMD and IMSD as per S&T load requirement. 2. Shall provide Electrical fittings including Tubelights, Fans, Sockets and Air-Conditioner as per S&T requirement in S&T Structures at Stations, IMDs and IMSDs. 3. Shall provide Fire Detection & Alarm System in SER, TER and S&T Power supply equipment rooms	
7	LT Power supply, E&M and associated work including Fire Detection & Alarm system for S&T installations at other than stations.	1. Shall advise space for positioning the ACO. 2. Shall share the S&T Equipment load requirement including requirement of Lights, Fans and Air-	1. Shall provide the ACO in coordination with S&T. 2. Shall design and provide LT power supply to S&T system as per their load requirement.	

Item No.	Item Description	Signalling & Telecom Contractor	Traction Electrification, E&M and associated Works Contractor (CP -204)	Reference Document if any
		conditioning. 3. Shall advise the requirement of Electrical fittings including Lights, Fans, sockets etc. in Signalling and Telecom structures.	3. Shall provide the Electrical fittings including Lights, fans, sockets etc. in Signalling and Telecom structures, as per S&T requirement. 4. Shall provide Fire Detection & Alarm System in SER, TER and S&T Power supply equipment rooms.	
8	Power Cable crossings	Shall take necessary precautions while laying the S&T Cables	Shall provide information of all Power Cable crossings along the track	Cable Route Plan
9	Communication channel/ bandwidth requirement for CCTV, Traction SCADA and Auxiliary SCADA	Shall provide fiber channels, bandwidth and also fiber line interface units as required.	Shall furnish their requirement of fibers, channels, bandwidth with details of locations where it is required.	Fibers/channel allocation diagram
10	Video Display System	Shall provide Video Wall Panels as required including display controller for display of SCADA information.	Shall coordinate and provide all SCADA information required to be displayed on the Video wall at Display controller provided by S&T.	
11	Provision/Configuration of Direct Line Consoles/ Telephones of Traction Power Installations	Shall provide Direct Line Consoles/Telephones for Traction Power Installations	Shall provide information about requirement of Direct Line Connectivity amongst Traction Power Installations.	

10.6.7 Contractor shall interface with System Works Contractor for Bhaupur-Khurja Section (Contract Package CP-104) for integration of Signalling & Telecom System as per the requirements stipulated in Particular Specification-Signalling Works and Particular Specification-Telecommunication Works.

10.6.8 Interface requirements specified above are by no means exhaustive and it remains the Contractors' responsibilities to develop, update and execute jointly Interface Requirements during design & throughout the execution of Works, to ensure that:

(1) all interface issues between the Contracts/Systems are satisfactorily resolved;

(2) design, supply, installation and testing of equipment are fully co-ordinated; and

(3) all equipment and facilities supplied under the Contracts are fully compatible with each other, whilst meeting the requirements of the respective Specifications.

10.6.9 Interface Requirements with Indian Railway

(1) Contractor shall liaison with designated authorities in Indian Railway to design Signalling & Telecom Arrangement for/at LC Gates serving both Indian Railway and DFCCIL. The design so finalised shall be submitted to Engineer for review. The contractor shall execute the so reviewed Telecom Arrangement for/at LC Gates serving both Indian Railway and DFCCIL.

(2) Contractor shall liaison with designated authorities in Indian Railway to develop integrated design of Mobile Train Radio Communication System based on GSM-R System as stipulated in relevant chapter of Particular Specification for Telecommunication. The design so finalised shall be submitted to Engineer for review. Contractor shall further liaison with designated authorities in Indian Railway for Installation, Testing & Commissioning of this integrated GSM-R System.

(3) Contractor shall liaison with designated authorities in Indian Railway to design Signalling and Telecom Arrangement for/at boundaries with Indian Railways. The design so finalised shall be submitted to Engineer for review. The contractor shall execute the so reviewed Telecom Arrangement for/at boundaries with Indian Railways.

End of Chapter-10

CHAPTER 11 - QUALITY ASSURANCE

11.1 General

11.1.1 The Contractor shall maintain and implement a quality management system that shall remain in effect during the execution of the Works. The Contractor's quality management system shall be tailored specifically to the Contract and the Works in accordance with ISO 9001 – Quality Management System, the latest edition of the International Standard ISO 9001, and the Contractor shall submit his quality management system titled as the Project Quality Assurance Plan for Engineer's review as specified herein.

11.1.2 The Project Quality Assurance Plan documentation shall include, but shall not be limited to the following:

(1) Project Quality Assurance Plan (Contractor's Integrated Quality assurance documentation);

(2) Design Quality Assurance Plan;

(3) Site Quality Assurance Plan (including Inspection and Test Plan);

(4) Manufacturing Quality Assurance Plans (including Inspection and Test Plan); and

(5) On-site Inspection Plan for Resources Procurement;

11.1.3 The Contractor shall plan, perform and record all quality control activities to ensure that all Works are performed in accordance with the requirements under the Contract and are detailed in the quality plans which are required herein. Such activities shall include, without limitation, the inspections and/or test expressly or implicitly required by the Contract.

11.1.4 Quality audits will be carried out by the Engineer and surveillance audit shall be carried out by Employer to verify the Contractor's implementation and compliance with the quality management system as specified herein.

11.2 Submission of Quality Documentation

11.2.1 Quality system documents to be submitted shall embrace all activities of the Contractor and his Sub-Contractors of any tier including his suppliers and any design consultants for the execution of the Works.

11.2.2 Within 42 days after the Commencement Date, the Contractor shall submit the following documents for review by the Engineer:

(1) Contractor's Quality Assurance Philosophy;

(2) Project Quality Assurance Plan; and

(3) Design Quality Assurance Plan and any associated work instruction and/or standard forms which the Contractor proposes to be used for the Contract.

11.2.3 The Contractor shall submit separate Site Quality Assurance Plan and Manufacturing Quality Assurance Plans for managing, controlling and recording the on-site construction and manufacturing process including off-site process for individual key items of the Works. The Manufacturing Quality Assurance Plan shall be submitted for review by the Engineer for his consent as part of Detailed Design development as described in the relevant chapters about

Manufacturing, Supply, Construction / Installation, Testing & Commissioning and Requirements on Documents and Drawings.

11.2.4 The Contractor shall submit separate On-site Inspection Plan for Resources Procurement for managing, monitoring and recording the on-site receipt of general construction resources including all construction material, labour forces and works and services delivered to the construction site. The On-site Inspection Plan for Resources Procurement shall be submitted for consent by the Engineer as part of Detailed Design development as summarized in Requirements on Documents and Drawings.

11.2.5 The Contractor shall continuously review and update the quality system documents to meet the requirements and development of the Works throughout the duration of the Contract. For any amendment to the quality system documents, the Contractor shall prepare and submit the proposed amendment for consent of the Engineer.

11.2.6 The Plan shall clearly define the Contractor's policy, Quality Assurance Organization, Management responsibility, the requirements for Quality Assurance personnel, their qualifications, skills and training, the Contractor's Quality Audit schedule.

11.2.7 Records of certifications shall be maintained and monitored by the Quality Assurance personnel. These records shall be made available to the Engineer / Employer for inspection and review as and when required.

11.2.8 The Quality Assurance operations shall be subject to the Engineer's verification at any time.

11.2.9 The verification will include surveillance of the operations to determine that practices, methods and procedures of the plan are being properly applied; inspection to measure quality of items to be offered for acceptance; and audits to ensure compliance with the Contract documents.

11.2.10 The Contractor's Quality Audit schedule shall be submitted to the Engineer for consent every three months or more frequently as required.

11.2.11 The Contractor shall provide all necessary access, assistance and facilities to enable the Engineer / Employer to carry out on-site and off-site Quality Audit / surveillance audit to verify that the Contractor's quality assurance system which has been consented by the Engineer, is being implemented fully and properly.

11.3 Controlled Copy of Quality System Documentation

11.3.1 The Contractor shall promptly supply the Engineer with six (6) controlled copies of his quality system documents duly consented by the Engineer. The Contractor shall maintain such controlled documents throughout the duration of the Contract. In addition, the Engineer may request further copies of the quality system documents and these documents shall reach to the Engineer office within fourteen (14) days of notification.

11.4 Project Quality Assurance Plan

11.4.1 The Project Quality Assurance Plan shall establish the Contractor's management structure which functions efficiently to execute the Works in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(1) A dedicated Quality Assurance Team

(2) A set of organization charts which depict in line with the Contractor's intent of the quality plans. Each organization chart shall identify the Contractor's managerial staff with reference to any member of the partnership, consortium or joint venture, and the main Sub-Contractors and indicate the reporting structure and the interface relationship between all parties involved;

(3) Each organization chart which may be subdivided with regard to Works segments, site locations, and phases and stages of the project to ensure complete implementation of the quality management system in every part to the Work.

(4) The Allocation of responsibilities and authorities given to managerial and technical staff with particular reference to the design and site supervision of the Works; and

(5) Hierarchy of the quality management system documentation for managing and controlling the whole system.

11.4.2 The Contractor shall submit the Curriculum Vitae (CV) of each member of his Quality Assurance Team and other personnel relevant to his quality management system. Assignment of such personnel shall be subject to prior consent of the Engineer.

11.4.3 The Project Quality Assurance Plan shall without limitation include Quality Assurance procedures for design, construction, manufacturing, supply, installation, testing and commissioning and shall contain control processes for each stage in the Work such as design verification and validation, management of change control, non-conformance procedures, control on sub-standard practices, inspection, testing, auditing and so on.

11.4.4 The Project Quality Assurance Plan shall also include a full list of quality management procedures, method statements, inspection and test plans, standards and protocol and/or standard forms which shall form the frame work of the Project Quality Assurance Plan. It shall define specific procedures to perform the quality management activities and to record the evidence of the activities performed and/or the results achieved. It shall detail the system and the procedure by which the Contractor shall ensure that

(1) The Quality Assurance Plan is fully observed at all times and

(2) Any non-compliant and sub-standard material, practice and / or work are brought back to compliance.

11.4.5 It shall cover the requirements of the International Standard ISO 9001 in compliance with the Contract as precedence requirements and shall, without limitation, include the basic management disciplines as follows:

(1) Review, approval and updating management of the quality system documents to ensure their continuing suitability and effectiveness;

(2) Design control management to all Permanent Works and/or Temporary Works including design works carried out by Sub-Contractors and sub-consultants. The procedures shall clearly define the review and verification procedures of the designs submittals and the design packages described under the Contract;

(3) Drawing management in the Contractor's main office and site office(s), including procedures of production, approval, updating, maintaining, storage and distribution;

(4) Document management including procedures of registration, updating, indexing, filing, maintenance, storage and distribution and monitoring and recording of the submission and re-submission to the Engineer;

(5) Monitoring, recording and control of the quality system of his Sub-Contractors with

respect to their quality of works with relevant time schedule; and

(6) Quality control of the Works including Quality audits to be held on the Contractor and Sub-Contractors, suppliers and design consultants of any tiers.

11.5 Design Quality Assurance Plan

11.5.1 The Contractor shall prepare the Design Quality Assurance Plan separately for its design Works. The Design Quality Assurance Plan shall establish the Contractor's policy for the design works in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

11.5.2 Organization of the Contractor's Design Team in context with the Contractor's entire organization so that it functions appropriately;

11.5.3 Allocation of responsibilities and authorities to be given to the Design Team, to the individual identified design staff and the Subcontractors for particular design works especially the Internal Authorization Process as detailed herein in Chapter-6 Design Requirements.

11.5.4 Hierarchy of relevant documentation (including drawings) of quality management system for managing and controlling design works including design works of Subcontractors of any tier to avoid conflicts in the design submissions; and

11.5.5 A list of general procedures to be applied to manage and control the quality of the design works.

11.5.6 The Functional procedures which maintains the Design Team in whole Contractor's organization to carry out the design works strictly in compliance with the Employer's Requirements and for the benefit of the Employer.

11.6 Design Review

11.6.1 Contractor's Design Team

(1) The Contractor shall be responsible for the design of the Works and shall ensure his design is correct / accurate and in compliance with the Employer's Requirements and Specifications contained in the Contract. The Contractor shall also be responsible for the construction, installation, testing and commissioning of the Works and shall ensure that all the completed Works are in line with his design and concurrently in compliance with the Employer's Requirements and safe.

(2) The Contractor shall establish his dedicated design team referred to as the Design Team in his organization to ensure that his design works are strictly in compliance with the Employer's Requirements and Specifications and for the benefit of the Employer. On the other hand, to clarify the responsibilities and the authorities, the Contractor shall also establish a Construction Team independent of the Design Team, thereby the Contractor shall be responsible for assuring the quality of the Works as required in the relevant Particular Specifications.

(3) **Sr. Design Engineer**

(a) The Contractor shall appoint fully qualified and experienced full-time Sr. Design Engineers. The Sr. Design Engineers shall act as a representative of Design Team and shall be wholly responsible for the Contractor's design Works.

(b) The Sr. Design Engineers shall be responsible for establishing, implementing, maintaining and recording Design Quality Assurance Plan.

(c) The Sr. Design Engineers shall be able to discharge his duties without any hindrance or constraint. Accordingly, the Sr. Design Engineers and his team shall strictly adhere to ISO 9001–Quality Assurance System of the Contractors, as consented by the Engineer so as to ensure that his decisions and activities with regard to the Quality Assurance be checked and monitored by the internationally acknowledged system. The Contractor shall identify the personnel to whom the Sr. Design Engineers shall be responsible and reports to and seek the consent of the Engineer for the same. The Contractor shall also identify personnel necessary under the supervision of the Sr. Design Engineers to furnish the Design Team to fully function as intended in the requirements herein and seek the consent of the Engineer. In addition, the Contractor shall make available any such resources that are necessary to ensure the effective implementation of the quality management system.

(d) The Contractor shall submit details of the authority and responsibility of the proposed Sr. Design Engineers for review and consent by the Engineer, as part of the Project Quality Assurance Plan.

11.6.2 Internal Authorization

(1) All design submissions including Detailed Design, Construction Design, As-Built Documents shall include a valid “Design Certificate” as per format given in Annexure-4 duly signed by Sr. Design Engineer in the Contractor’s Design Team and Contractor’s authorized Representative, thereby demonstrating that:

(a) Design of the Permanent Works complies with the relevant Particular Specifications

(b) In-house checks have been undertaken to conform the completeness, adequacy and validity of the design as per all the quality assurance procedures

(c) All the required approvals have been obtained

(d) Design has been performed and finalized utilizing the skills of a professionally qualified, competent and experienced designers and engineer(s)

11.6.3 The Contractor shall fully verify the respective design outputs as a set of submissions through the Internal Authorization Process by signing and attaching ”Design Certificate” as the covering document.

11.6.4 After receiving the “Notice of No Objection’ or “Notice of No Objection with Comments” in respect of the Construction Design, all the original paper drawings in respect of Working Drawings shall be endorsed as “Good For Construction” by Sr. Design Engineer before issuing it to the Site or submitting to the Engineer for his endorsement as specified in Chapter-6 - Design Requirements.

11.7 Site Quality Plan

11.7.1 On-site Quality Management Provisions

The Contractor shall prepare a Site Quality Plan separately for the construction and installation of Works. The Site Quality Plan shall include the comprehensive on-site quality

management in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(1) Organization of the Contractor's staff directly responsible for the day-to-day management of the construction and installation activities to execute the Works on the site;

(2) Allocation of responsibilities and authorities given to identified personnel or Subcontractors for particular construction and installation of the Works;

(3) Hierarchy of relevant documentation (including drawings) of quality management system for managing and controlling construction and installation of the Works including construction and installation works of Subcontractors of any tier to avoid conflicts in the execution of the Works; and

(4) A list of sequences to be applied to manage, control and record the construction and installation of the Works.

11.7.2 On-site inspection and test provisions

(1) The Contractor shall also prepare onsite inspection and test plans to manage, control and record any test and inspection activities. The Inspection and Test Plans shall be established for particular activities which require inspection and/or test to meet the quality level required in the Employer's Requirements and as included in any form in the Contractor's design and the Works Specifications. It shall cover the requirements of International Standards ISO 9001 and in compliance with the Contract

(2) The Contractor shall prepare and maintain a full list of the all Inspection and Test Plans needed under the Contract with submission status and review status and shall submit to the Engineer for his consent.

(3) Each Inspection and Test Plan for the particular activity shall define, without limitation:

(a) Scope of activities covered by the plan;

(b) A sequence of the Work related to the activities in the scope;

(c) Personnel responsible for undertaking the inspections and/or tests and the personnel responsible for certifying the inspections and tests;

(d) Inspections and/or test methods, their frequency, and/or reference material to the relevant standard of the inspections and/or the tests;

(e) Compliance criteria of the inspections and/or tests with clear descriptions of the quality hold point and the quality control point;

(f) Documents to be used for reporting the results of the inspections and/or tests with sample documents incorporated into the Plan; and

(g) Methods of record keeping and document storage as to the locations to be maintained / stored and procedures for those to be acknowledged / filed.

11.8 Manufacturing Management and Quality Assurance Plans

11.8.1 Manufacturing Quality Management Provisions

(1) The Manufacturing Quality Plans shall define the Contractor's management structure and quality management system for the manufacturing process of the key items of the

Works and for the items as requested by the Engineer. Separate Manufacturing Quality Assurance Plans shall be prepared for each manufactured item and submit them to the Engineer for consent.

(2) Each Manufacturing Quality Assurance Plans for manufacturing process management shall be established in compliance with the Employer's Requirements under the Contract and shall, without limitation, define as follows:

(a) Scope of activities and items covered by the plan;

(b) Organization of the Contractor and/or the Subcontractor responsible for the day to day management of the manufacturing process of the items;

(c) Allocation of responsibility and authority given to identified personnel for the day to day management of the manufacturing process with particular reference to the supervision, inspection and testing of the process and manufactured items;

(d) Specific methods including handling and management of the manufacturing process and manufactured items, including but not limited to the following:

(i) Particulars of the material to be used in the manufacturing process;
(ii) Monitoring and management of manufacturing process in compliance with the approved drawings and specifications;
(iii) Identification or referencing procedures for traceability of the manufactured items;
(iv) Identification of the inspection and test status of the material and the final manufactured item;
(v) Disposition of nonconforming material and the manufactured item;
(vi) Handling, storage, packaging, preservation and delivery of the manufactured item; and
(vii) Procedure of monitoring and recording of the ordering and delivery of the item.

11.8.2 Manufacturing inspection and test provisions

(1) The manufacturing inspection and test plans to be prepared by the Contractor shall cover all the requirements.

(2) In addition to the inspection by the Contractor and the Engineer, the Employer may, at his own cost, depute its representative or nominate any other independent inspection agency for supervising, monitoring and inspection of raw material and manufacturing process at the factory. In order to facilitate such an inspection, the detailed production/manufacturing plan shall be provided by the Contractor to the participants of the inspection as well as to the Engineer at least six weeks in advance of the commencement of the manufacturing process along with the description of mandatory specifications and tests proposed during the manufacturing process and the tests intended to be conducted on the finished product along with codal permitted tolerances.

11.9 Software Quality Assurance Plan (SQAP)

11.9.1 Each software supplier for Contractor will assure software dependability by establishing and implementing a Software Quality Assurance Plan (SQAP). The SQAP will:

(1) Identify, monitor and control all technical and managerial activities necessary to ensure that the software achieves the required quality.

(2) Ensure that an audit trail is established which enables verification and validation that the SQAP activities were effectively completed.

11.9.2 Each software supplier will provide evidence that the SQAP activities were carried out, by submitting the documents in given in the Table below.

Documentation
Software Project Management Plan
Software Quality Assurance Plan
Software Configuration Management Plan
Software Verification and Validation Plan
Software Requirements Specification
Software Design Description
Traceability

11.10 On-site Inspection Plan for Resources Procurement

11.10.1 The Contractor shall establish On-site Inspection Plan for Resources Procurement for managing, monitoring and recording the on-site receipt of general construction resources including all construction material, labour forces and works and services delivered to the Site and the Temporary Facilities e.g. assembly and tests on assemblies prior to installation, their stacking and storage etc. in the Work Areas .

11.10.2 Onsite Inspection Plan for resources procurement to be prepared by the Contractor shall cover all the requirements as described in GS and PS.

11.11 Tests

11.11.1 Tests to be carried out for quality assurance purposes shall be as specified in the Particular Specifications Volume 2 and Volume 3 and as per the Quality Assurance Plan / Inspections and Test Procedures duly approved by the Engineer.

11.11.2 The Contractor may employ other tests to further ensure the quality of the Works. In such a case, the Contractor shall be responsible for obtaining prior approval from the Engineer by submitting the test plans with regard to the application of the tests as part of the Project Quality Assurance Plan or its sub-plans.

11.11.3 Test Plan and Procedure

The Contractor shall submit all test plans and procedures for review by the Engineer at least 30 days prior to conducting any test together with the exact time and date of such tests. Test procedures show the following unambiguously but not limited to:-

(1) List of resources that shall carry out the various testing activities and their capabilities.

(2) Date on which the Contractor proposes to conduct each of these listed tests;

(3) nature and purpose of test;

(4) extent of testing covered by each submission;

(5) method of testing and tests requirements with the relevant standards;

(6) relevant drawing and document (or modification) status;

(7) location of testing;

(8) test parameters to be measured with the relevant standards;

(9) constraints to be applied during the test with the relevant standards;

(10) defined pass/fail criteria with relevant standards;

(11) format of the raw data for processing by the Contractor; and

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

11.12 Quality Audits

11.12.1 The Contractor shall carry out quality audits on the Works at quarterly intervals or at such other intervals as the Engineer may require, ensuring the continuing suitability and effectiveness of the quality management system. Reports of each such audit shall be submitted promptly to the Engineer for review.

11.12.2 The Contractor shall submit, for review by the Engineer, details of the authority, qualifications and experience of personnel assigned to quality audit activities before carrying out quality audits.

11.12.3 The Engineer may require quality audits on the Contractor and his Subcontractors to be carried out by his representative or the Employer's staff. In such case, the Contractor shall afford to such auditors all necessary facilities and access to the activities and records to permit this function to be performed.

11.12.4 Upon receipt of corrective action request (CAR) or similar document issued by the Engineer as a result of quality audits, the Contractor shall promptly investigate the matter and submit the proposed corrective and preventive actions within 14 days to the Engineer for review. The Contractor shall take timely corrective and preventive actions to rectify the matter and to prevent re-occurrence. Evidence to demonstrate effective implementation of corrective and preventive actions shall be submitted by the Contractor to the Engineer for review.

11.13 Notification of Non-Conformities

11.13.1 If, prior to an issue of the Taking-Over Certificate for the Works or the relevant Section, the Contractor proposes to repair any item of the Works which does not conform to the requirements of the Contract, the Contractor shall immediately submit for review by the Engineer of such proposal and supplying full particulars of the nonconformity and, if appropriate, of the proposed means of repair.

11.13.2 If the Engineer issues nonconformity report or similar documents to notify the Contractor of any item of the Works which does not conform to the requirements of the Contract, the Contractor shall promptly investigate the matter and within 14 days of notification by the

Engineer, submit to the Engineer for review the remedial measures and necessary actions to be taken to rectify the item and to prevent re-occurrence.

11.13.3 The Contractor shall maintain and update a nonconformity register to indicate the status of all nonconformities which are identified by the Engineer/ and or the Contractor. The Contractor shall submit the register for review upon request by the Engineer.

11.14 Monthly Progress Report on Quality Management System

11.14.1 The Contractor shall continuously monitor the performance of the quality management system and shall include the same in each Monthly Progress Report as required in Monthly Progress Report.

11.14.2 The Contractor shall provide and maintain, at all stages of the Works, a quality control register(s) to identify the status of inspections, sampling and testing of the work and all certificates. Such register shall be updated by the Contractor to show all activities in previous months and shall reach the Engineer's office before 7th working day of each month. Each register shall:

(1) List the certificates received for each batch of goods and material incorporated in the Works and compare this against the certification required by the Contractor and the Contractor's quality plans;

(2) List the inspection and testing activities undertaken by the Contractor on each element or segment of the Works and compare these activities against the amount of inspection and testing required by the Contract and the Contractor's quality plans;

(3) Show the results of each report of inspection and/or test and any required analysis of these results and compare these results against the pass/fail criteria; and

(4) Summaries any actions proposed by the Contractor to overcome any nonconformity.

11.14.3 The Engineer shall submit the same to the Employer along with his observations / comments before 15th working day of each month.

11.15 Quality Records

11.15.1 The Contractor shall ensure that all the quality records as objective evidence of the implementation of the quality management system are properly indexed, filed, maintained, updated and securely stored.

End of Chapter-11

CHAPTER 12 - RELIABILITY, AVAILABILITY, MAINTAINABILITY & SAFETY (RAMS)

12.1 General

12.1.1 The Reliability, Availability, Maintainability, & Safety activities shall be undertaken throughout the whole course of the project as an Integral part of System Assurance in order to demonstrate in a logical, progressive and traceable manner that:

(1) The objectives and requirements of the project have been satisfied.

(2) All systems and components of the works are defined appropriately with verifiable performance benchmarks.

(3) Proper designs, Calculations and Simulation tools have been used.

(4) The work has been executed by suitably competent people.

(5) The designs have been verified by the competent authorities.

(6) Any manufacturing, construction, installation, testing and commissioning works associated with the project have been validated.

(7) Safety related aspects of the systems have been identified, analysed and risks mitigated such that residual risks have been demonstrated to be as low as reasonably practicable for all project stages.

(8) RAMS requirements of the Systems have been identified, apportioned to various subsystems and elements of the works and the associated designs for these have been demonstrated to be capable of meeting their allocated performance targets.

12.1.2 The activities shall apply to software design as well as hardware and hardware application designs.

12.1.3 The Contractor shall co-ordinate results of analysis with each engineering discipline, particularly as the results affect engineering and hardware development.

12.1.4 The Contractor shall make recommendations for reengineering or modifications necessary to assure compliance with specified requirements including redundancy, utilisation of high reliability components, built-in self-diagnostics and “self-healing”; utilisation of in-service status displays to enhance fault isolation and test; easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

12.1.5 The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

12.2 Reliability-Availability-Maintainability-Safety (RAMS) Plan

12.2.1 The RAMS Plan shall be maintained as a live document and updated as necessary throughout the duration of the Project.

12.2.2 The RAMS Plan shall define the Contractor’s approach on systematic compliance to relevant System Requirement Specifications, procedures and schedules for conducting the Reliability, Availability, Maintainability and Safety Engineering.

12.2.3 RAMS Plan shall describe the organization, resources and procedures that will be established to manage system assurance activities. It shall clearly defining the responsibilities of personnel directly associated with system assurance activities and implementation of the programme.

12.2.4 The RAMS Plan will describe the RAM and Safety Assurance activities throughout the project lifecycle, comprising Design, Manufacturing & Production, Construction & Installation, Testing & Commissioning and Operation.

12.2.5 The RAMS Plan shall describing the procedures to perform the specific RAMS tasks necessary to meet Reliability, Availability, Maintainability and Safety requirements.

12.2.6 The RAMS Plan shall include application of the relevant standards, norms, regulations, instructions and the Employer's Requirements/Specifications.

12.2.7 The Contractor shall liaise with the Employer/Engineer to establish a comprehensive program of work that will encompass all the requirements of this plan in a time scale that enables the construction, installation, testing, commissioning, putting to work and warranty monitoring to be undertaken in good time to meet the overall time scales of the project.

12.2.8 The Contractor shall submit a Compliance Matrix in the RAMS Plan with all phases mentioned above and tasks to be performed and the deliverables to be submitted for demonstration of compliance with RAMS requirements. These requirements shall also be applied to sub-contractors.

12.3 Compliance management

12.3.1 A compliance management process shall be established and maintained for the duration of the Project to:

(1) Import all RAMS requirements from the Project documents and ensure compliance to Technical Specifications and System Requirements Specifications.

(2) Import design requirements and specifications from each stage of design as they are developed and assess the impact of any changes in these.

(3) Provide traceability to demonstrate that high level and low level design requirements and specifications have been verified that they satisfy the RAMS requirements.

(4) Provide traceability of review comments made and the associated responses and follow up actions.

(5) Provide traceability of non-conformances and follow up actions required to address them.

(6) Provide traceability of validation of testing and commissioning results against RAMS requirements or design requirements and specifications.

(7) Provide summary reports on key status items including, but not limited to requirements not yet satisfied and incomplete or missing verifications or validations.

12.4 Verification & Validation

12.4.1 Verification and Validation activities shall be undertaken to show in a logical, progressive and traceable manner that the:

(1) The designs satisfy the RAMS requirements

(2) The completed works that have been subjected to testing and commissioning indeed demonstrate that they meet the RAMS requirements.

12.4.2 Verification & Validation shall be carried out preferably by an engineering team who are independent from those carrying out the design.

12.4.3 All the equipment & components/ Products used in the Contract shall be approved only when the Engineer/ Engineer has been satisfied as to their strength, reliability and suitability. To assist the Engineer in this respect, the Contractor shall furnish on request, performance data, references to completed works and any other relevant information together with samples of materials for approval.

12.4.4 Verification methods shall include one or more of the following:

(1) Analysis of design

(2) RAM studies

(3) Design safety studies

(4) Simulations

(5) Calculations

(6) Benchmarking against international best practice where appropriate, and

(7) other methods as appropriate.

12.4.5 Records of all verification and validation activities shall be kept and shall be traceable through the Compliance Management Process.

12.5 RAMS Organization

12.5.1 The RAMS Organization of the contractor shall have dedicated RAM and Safety Managers who shall have implemented the RAMS strategy for the relevant system in at least one Metro/railway project environment.

12.5.2 Alternately, the Contractor shall retain the services of a RAMS consultant to manage the entire scope of the RAMS work.

12.6 System RAM Management

12.6.1 RAM Management activities shall be undertaken in order to demonstrate in a logical, progressive and traceable manner that the works satisfy the requirements of the project pertaining to RAM.

12.6.2 **RAM Activities**

(1) **Design Phase** - The RAM activities will include:

(a) Develop detailed RAM allocations for subsystems, assemblies, and equipment.

(b) Perform Reliability, Maintainability and Availability analyses at the Preliminary Design phase.

(c) Perform detailed Reliability, Maintainability and Availability analyses and Prediction at the Final Design phase.

(d) Perform FMECA

(e) Integrate RAM design and analysis results into test planning, maintenance planning, maintenance manuals, and operating manuals.

(f) Establish FRACAS

(2) **Construction and Installation Phase** - The RAM activities will include:

(a) Updating of Reliability, Maintainability and Availability analyses and Prediction

(b) Updating FMECA

(c) Preparation of Reliability, Maintainability and Availability Demonstration Plans

(3) **Testing, Trials and Warranty Phase** - The RAM activities will include:

(a) Perform RAM Demonstration.

(b) Execute a Failure Reporting and Corrective Action System (FRACAS).

(c) Provide all necessary reports and documentation for tracking by the V&V process.

(4) Details of the above mentioned RAM activities are enumerated in succeeding sections.

12.6.3 **RAM Analysis and Prediction**

(1) Contractor will undertake a RAM Analysis and Prediction of the system. The RAM Analysis will provide an initial and broad assessment of all known service failure and service interruption modes for top level events such as minor, major, and immobilizing service interruptions.

(2) The purpose of the RAM Analysis is to ensure that the potential service failure modes, causes, and mitigations are well understood by all parties as the design, integration, fabrication, testing, and acceptance activities move forward.

(3) Reliability will be assessed in terms of the MTBF/MTBSAF. The assessment will have a bottom up approach commencing from the LRU level and proceeding up to the sub-system and system level. MTBF/MTBSAF is the predicted elapsed time between inherent failures/service affecting failures of a system during operation.

(4) The RAM Analysis will also be used to identify and select service failures for in-depth assessment in the Fault Tree Analysis (FTA).

(5) The Contractor will provide a first iteration of the Reliability Prediction Report for employer's approval. Reliability Prediction Report will be periodically updated until the task is concluded.

(6) Reliability Predictions will be conducted at the appropriate level of detail to ensure adequate reliability and fulfilment of the specifications and RAM requirements. This may entail conducting an analysis at the subsystem, assembly, lowest replaceable unit (LRU), block, element, or component level, and may require combining differing analyses from different levels for a single subsystem.

(7) Reliability Predictions will be based on existing performance records, reliability test data, warranty and operating data, and reliability prediction analyses from previous similar projects. For equipment with incomplete or inconclusive operating, failure, and/or reliability demonstration data, the equipment supplier will develop a reliability prediction using other information sources, such as, MIL□HDBK□217F Notice 2, Non

electronic Parts Reliability Data (NPRD), Manufacturer test data, or any other well□established industrial reliability prediction databases.

(8) The reliability predictions will be subject to confirmation during the Reliability Demonstration Test.

12.6.4 **Failure Mode, Effects, and Criticality Analysis (FMECA)**

(1) FMECA is a systematic procedure for the analysis of a system to identify the probability of occurrence and severity of the potential failure modes, their respective causes and immediate and final effects on systems performance (performance of the immediate assembly and their entire system) and to provide an input to mitigating measures to reduce risk.

(a) FMECA will be performed and updated at different project stages until the task is concluded. The FMECA will be intended to:

(b) Undertake decomposition of the System, Sub-systems from the highest level till the LRU level.

(c) Provide the lowest level analysis of failures and failure effects on the system and its subsystems and equipment.

(d) Identify weaknesses in system hardware and software design and analyse failure modes and effects, particularly for when these details are not established by historical records of equipment operation.

(e) Use inductive logic in a “bottom up” system analysis. This approach begins at the lowest level which is the Lowest Replaceable Unit (LRU) of the equipment under analysis and traces consequences up to the system level to determine the end effects on sub-system and system performance.

(f) Identification of single failure points critical to proper system performance.

(g) Provide early visibility into potential system interface problems.

(h) Perform Criticality Analysis (CA) of the list of possible failure modes by ranking them in accordance to their risk which is dependent on the probability of occurrence and severity of the failure. The CA will allow prioritization of mitigation measures.

(2) The purpose of FMECA will be to identify:

(a) Those failures which have unwanted effects on safety

(b) Those failures which have unwanted effects on system operation

(c) Those failures which have unwanted effects on overall reliability

(d) To allow improvements of the systems safety

(e) To allow improvements of the systems reliability

(f) To allow improvement of the systems maintainability

(g) To allow improvements in the systems availability

12.6.5 **Reliability Critical Item List (RCIL)**

(1) The contractor will perform Reliability Analysis to identify Reliability Critical Items List (RCIL). Reliability critical items are those items that have a significant impact on product reliability, performance, safety, availability or life cycle cost. Identifying and

controlling critical items is imperative since these parts are often the parts that drive unreliability.

(2) A critical item output report will be submitted to ensure that reliability critical components were identified and controlled; reliability predictions and an FMECA were performed. Critical items will be identified via the failure rates noted in the prediction and by the single failure point analysis performed in the FMECA.

12.6.6 **Maintainability Analysis and Predictions**

(1) The contractor will perform analytical maintainability analysis and prediction to assure compliance with the specific maintainability requirements and to ensure system performance.

(2) Maintainability will be assessed in terms of MTTR. The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including software re-boot, up to the point the system is restored to full functionality.

(3) The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

(4) In all availability calculations the following access times shall be assumed:

(a) 1 hour for signalling equipment

(b) 2 hours for telecommunication equipment

(5) In the maintainability analysis, the contractor will lay special emphasis on features such as Built-in-Test (BIT) and fault isolation, acknowledging the criticality of these features to the effectiveness of system testability and maintainability. Built-in-Testing goals should be established that provide the attainment of highest fault coverage detection and isolation to the Lowest Replaceable Units (LRUs).

(6) The contractor will perform Maintainability Analysis to identify Maintainability Critical Items List (MCIL). The maintainability critical items are those items that have a significant impact on product maintainability, performance, availability or life cycle cost. Identifying and controlling critical items is imperative since these parts are often the parts that drive system downtime.

12.7 System Safety Management

12.7.1 **Principle of Safety Management**

(1) System Safety Management activities shall be undertaken to demonstrate in a logical, progressive and traceable manner that the works satisfy the safety requirements of the Project.

(2) The basic principle of safety management shall be that all reasonably foreseeable hazards are identified and action then taken for each hazard as follows:

(a) Risks arising from the hazard shall be assessed.
(b) If the risk is broadly acceptable no further action shall be required, otherwise measures shall be taken to reduce or eliminate the risk.

(c) Each of these measures shall become a 'safety requirement' and all safety requirements shall be subject to verification and validation processes to show that they have been met by design and later by practical tests.

(d) The mitigation, verification and validation status of all hazards shall be recorded in the Hazard Log.

12.7.2 **System Safety Plan**

The System Safety Plan shall be developed in accordance with EN 50126 and shall include but not be limited to the following subjects:

(1) Safety policy;
(2) Risk acceptance criteria;
(3) Risk management and Principles;
(4) Hazard Analysis and Hazard Log
(5) Design safety studies;
(6) Management of safety during integrated testing, trials, and commercial operation.

12.7.3 **Safety Policy**

The proposed approach and commitment to safety shall be specified in a statement of safety policy endorsed by the submitter's senior management and this statement shall be included in the System Safety Plan.

12.7.4 **Hazard Analysis**

(1) Hazard analysis shall be carried out to:
  (a) Identify and record all reasonably foreseeable hazards associated with all phases of the Works;
  (b) Assess the risk that each hazard represents to this operation; and
  (c) Re-assess the risk after application of the proposed mitigation.

(2) Where it is not reasonably practical (based on good practice or application of the ALARP principle) to eliminate hazards at the design stage, risk assessments shall be carried out to ensure that the risks associated with residual hazards are in order of precedence:
  (a) Minimized through mitigation measures at the design stage;
  (b) Mitigated through special construction, installation and testing and commissioning processes; and
  (c) Mitigated through operations and maintenance procedures.

(3) Additional mitigation measures shall be proposed as required until such time as the residual risk is assessed to be 'as low as reasonably practicable'.

(4) The results of the hazard analysis shall be recorded in a Hazard Log in a form that can be used to track progress in the implementation of mitigating actions and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard.

12.7.5 **Primary hazards for Preliminary Hazard Analysis (PHA)**

(1) The PHA shall take into account, but not be limited to, the following primary hazards:

(a) fire including:
  (i) smoke asphyxiation;
  (ii) hot works; and
  (iii) explosion;
(b) impact including:
  (i) collision;
  (ii) derailment;
  (iii) falling objects;
  (iv) flying objects;
  (v) sharp objects;
  (vi) slipping, tripping and falling;
(c) electrocution;
(d) other hazards including:
  (i) environmental;
  (ii) flooding;
  (iii) noxious fumes;
  (iv) suffocation;
  (v) entrapment; and
  (vi) burns.

(2) The PHA shall take into account the various types of operating mode (i.e. normal, degraded and emergency) and the operating scenarios during which all types of hazards might exist including, but not limited to:

(a) freight service;
(b) evacuation; and
(c) maintenance.

(3) The PHA shall take into account how each type of hazard might arise including, but not limited to:

(a) inappropriate design or specification;
(b) equipment failure;
(c) installation error;
(d) improper action (accidental or deliberate);
(e) inaction (unintentional or intentional); and
(f) external influence.

(4) The PHA will be followed by detailed hazard analysis:-

(a) Sub System Hazard Analysis (SSHA)
(b) Interface Hazard Analysis (IHA)
(c) Operating and Support Hazard Analysis (O&SHA)

(5) The hazard analysis will be supported by following assessment methods:

(a) Failure Mode, Effects and Criticality Analysis (FMECA)
(b) Fault Tree Analysis (FTA) of top level hazard scenarios.

12.7.6 **Design Safety Studies and Report**

(1) The hazard analysis process shall identify the need for Design Safety Studies and the Hazard Log shall record the results of each of these Design Safety Studies.

(2) Design Safety Studies shall be undertaken for system and subsystem elements that are considered to be safety critical and that require hazard analysis to a greater level of detail than that applied at an overall system wide level.

(3) Design Safety Studies shall specifically refer to hazards arising from:

(a) normal operations including maintenance;
(b) degraded modes of operation;
(c) emergency situations; and
(d) the effectiveness of mitigation proposed for natural catastrophes.

(4) The Design Safety Studies shall take account of:

(a) methods of operation;
(b) RAM considerations;
(c) anticipated likely maintenance regimes and their sustainability in Commercial Operation;
(d) anticipated competence levels of personnel in Commercial Operation;
(e) software security (disabling of unauthorized access to operating systems, protection against intrusive attacks, loss of password integrity, etc.); and
(f) other human factors including but not limited to those identified in ergonomic studies.

(5) Design/Systems Safety Studies and the Report shall demonstrate, as a minimum, the following requirements:-

(a) That the overall risk criteria for the Works have been addressed satisfactorily at the Detailed Design stage and that the Detailed Design proposals are mutually compatible with such risk criteria.
(b) That all Safety Critical systems have been identified at the Detailed Design stage and the apportionment of risk factors between the major systems and sub-systems support the overall safety criteria approved in the “System Safety Plan”.
(c) That the results of the Design Safety Studies have been incorporated into the design, and shall be carried forward into the Final Design, manufacturing and installation processes.
(d) That where management by operating and/or maintenance procedure or other management control measures have been identified during the “Design Safety Studies”, auditable methods by which such measures shall be introduced into operating/maintenance provisions have been established.
(e) That robust processes have been implemented to validate the Safety Critical aspects of software design.
(f) That processes for assessing the potential safety impact of design changes exist.

(6) A Design Safety Studies and Report shall be submitted at the completion of the design stage to confirm that all safety related aspects of design have been properly addressed and comprehensively verified.

12.8 RAM Demonstration

12.8.1 Reliability Demonstration

(1) The Contractor will perform a Reliability Demonstration to verify that the system meets the required reliability performance requirements when:

(a) Scheduled maintenance is performed in accordance with approved Maintenance Plan and Maintenance Manuals, and
(b) Systems are operated within the environmental limits described in the Design documents.

(2) The demonstration of the system will continue for a period of 24 months. If at the end of the 24 month test period the equipment has not met the reliability requirements, the System Supplier will implement design changes or modifications, as needed, to meet the reliability requirements. The test duration will be extended to ensure that the changes made result in achieving the requirements.

(3) The Contractor will submit a RAM Demonstration Test Plan before the Final Design Review. The plan will address the following to illustrate compliance with the reliability requirements:

(a) Plan schedule and period
(b) Identification of necessary facility, resources, support equipment, and staff for the demonstration
(c) RDT procedures and forms for recording and submitting data
(d) Success failure criteria for measuring reliability values for individual equipment items and subsystems
(e) Failure analysis of reported failures to identify the cause and need for corrective action
(f) Establish a Failure Review Board (FRB) to meet with Employer, as required, to determine the need and depth of failure analyses
(g) Change control procedures for implementing design changes
(h) Format and location of test records, test logs, and data records
(i) Final conclusion and report for the demonstration.

(4) The Employer will approve the RAM Demonstration Plan and procedures before the trial commences.

(5) The RAM Demonstration Procedures will include all information necessary to ensure the successful, accurate and safe performance of the demonstration testing. The RAM Demonstration Procedures will include, as required:

(a) Safety Precautions
(b) Identification of the reliability performance parameters that are verified by the test
(c) Scope of test

(d) Test equipment required, if any.
(e) Personnel required
(f) Any special conditions required, including condition of the equipment under test
(g) Reference drawings or documents
(h) Clear pass/fail criteria
(i) Data sheets to record test results
(j) Raw data correlation procedures

(6) RAM Demonstration Procedures will address the following:

(a) Each equipment failure reported during the RAM Demonstration will be classified as relevant or non-relevant failures by the Failure Review Board (FRB). The assessment will include all failures, whether occurring in or out of revenue service.
(b) A proposed procedure for corrective action will be developed and included. The procedure will include proposed changes and appropriate supporting data. The procedure will identify a specific method for verifying the effectiveness of change(s).
(c) Preventive maintenance procedures specified for the equipment during the RAM Demonstration phase will be performed by the maintainer in accordance with applicable Contract Terms and Conditions.
(d) System suppliers will maintain records which contain all the information necessary to calculate reliability performance for the system and major subsystems, and to verify satisfactory reliability requirements. System suppliers will provide failure records to employer in hard copy and in an approved electronic format.

(7) A chargeable failure in the RAM Demonstration is defined as any relevant failure that requires repair or replacement of any subsystem or vehicle component. Chargeable failures also include intermittent failures, unverified failures, and software failures.

(8) Non-chargeable failures in the RAM Demonstration are:

(a) Consumable items, except for those which are not achieving their specified life
(b) A failure occurrence in equipment of another subsystem, due to the primary failure
(c) A failure of the operator/maintainer to perform recommended preventive maintenance actions
(d) Vandalism or physical mistreatment at a human interface
(e) Failures due to an accident.

(9) The Contractor will provide Weekly Failure Reports during the RAM Demonstration phase. The Contractor will submit the format and structure of the report to employer for review and approval at least three months before system commissioning begins.

(10) The Contractor will submit Monthly Demonstration Test Reports to employer documenting the current and cumulative failure totals for the system equipment, comparing the totals to the reliability requirements.

12.8.2 **Availability Demonstration**

(1) The Contractor shall demonstrate the specified Availability during Service Trials and during the DLP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

(2) In the event that the availability target is not achieved, the determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

(3) In the event that the availability target is not achieved, the Contractor shall, at his own expense, take whatever action as deemed necessary to meet the availability requirement.

(4) The contractor will submit the Availability Demonstration Test Report on completion of the demonstration testing.

12.8.3 **Maintainability Demonstration**

(1) The Contractor will conduct a Maintainability Demonstration (MD) to establish the accuracy of task time estimates for the preventive and corrective maintenance tasks described in the applicable Maintenance Plan, Maintenance Procedures, and/or Maintenance Manuals. The Contractor will perform the MD concurrent with the DFCCIL personnel training program. The Contractor and S&T System/Sub-system Supplier(s) will demonstrate selected servicing, preventive maintenance, troubleshooting, change out of components, corrective maintenance, and use of special tools where special emphasis, instruction, or proficiency is needed. DFCCIL will notify System Suppliers which preventive and corrective maintenance tasks have been selected for the MD.

(2) Maintainability Demonstration Test Plan will be provided before the Final Design Review.

(3) In the event that any maintainability target is not achieved, the Contractor shall at his own expense take action as required to meet the maintainability targets.

(4) The contractor will submit a Maintainability Demonstration Test Report on completion of the demonstration testing.

12.9 Failure Reporting and Corrective Action System (FRACAS)

12.9.1 **Purpose of FRACAS**

The Contractor will provide a Failure Reporting and Corrective Action System (FRACAS) that supports requirements of the RAM Demonstration and Warranty Program. The contractor will submit the FRACAS for employer's approval before the Final Design Review. The Contractor will use a Failure Reporting, Analysis and Corrective Action System (FRACAS) to track and report on system failures. The FRACAS will consist of a set of data management tools for capturing and reporting on equipment incident data, and a set of procedures which use the data management tools. The FRACAS procedures:

(1) Implement key project functions of reliability demonstration and warranty administration

(2) Assess compliance of delivered equipment with requirements

(3) Provide field and operating information to equipment and project design and analysis tasks

(4) Assess the effectiveness of modifications to equipment in the field.

12.9.2 Where system failures indicate the possibility of a non-compliant design, the FRACAS process will consist of the following activities:

(1) Communication of failure information from the operating authority to the S&T System Suppliers

(2) Assessment of the failure conditions, impacts, and possible causes by the S&T System Supplier Quality Assurance, Electrical and Engineering departments, and by equipment suppliers

(3) Where appropriate, failure analysis by the equipment supplier

(4) Corrective action by the equipment supplier

(5) Once corrective action has been completed through field or factory action, verification by the System Supplier that the implemented solution is adequate and acceptable.

12.9.3 **FRACAS Guidelines.**

(1) A comprehensive FRACAS closed loop diagram is shown below:

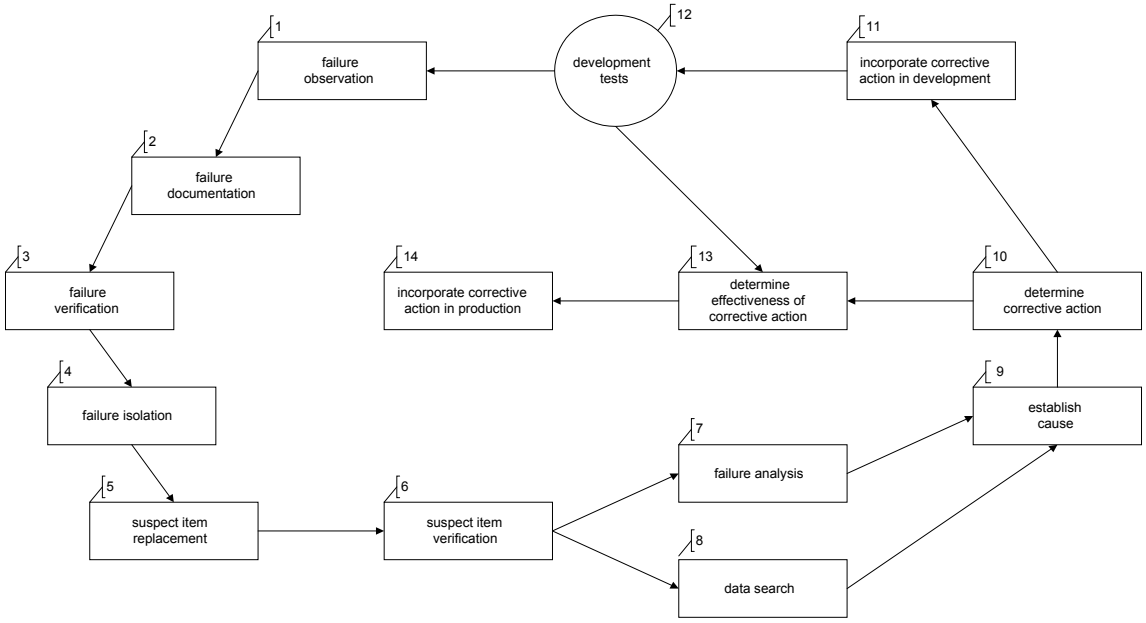


Figure 1: Generic Closed-Loop FRACAS

(2) Key steps in FRACAS are as follows:

(a) Observation of failure
(b) Complete documentation of failure including all significant conditions which existed at the time of the failure
(c) Failure verification, i.e. confirmation of the validity of the initial failure observation
(d) Failure isolation, localization to the lowest replaceable defective item within the product
(e) Replacement of the suspect defective item

(f) Confirmation that the suspect item is defective
(g) Failure analysis of the defective item
(h) Data search to uncover other similar failure occurrences and to determine the previous history of the defective item and similar related items
(i) Establishment of the root cause of the failure
(j) Determination, by the design team, of the necessary corrective action, especially any applicable redesign
(k) Incorporation of the recommended corrective action into development equipment
(l) Establishment of the effectiveness of the proposed corrective action
(m) Incorporation of effective corrective action into the equipment
(n) The failure documentation should be augmented with the verification of failure (step c) and verification that the suspect part did indeed fail (step f).

12.9.4 **Reporting of Failure**

Failure Report Forms: All failures shall be recorded on a failure report form which shall contain as a minimum the following information:

(1) Identification of the equipment, including nomenclature, serial number, manufacturer's part number and location;
(2) Location of failure;
(3) Individual who observed failure;
(4) Operating time of each system including each shut-down and its cause;
(5) Date and time of each incident;
(6) Failure symptom/indication, mode, cause and effect;
(7) Classification of the incident (relevant independent failure or dependent failure);
(8) Corrective maintenance or operational procedures required to restore the System to operation;
(9) Time to restore System to operation and active repair time; and
(10) Circumstances of interest such as Environmental conditions and supply voltages.

12.9.5 **Failure Database**

The key to a successful FRACAS is its database. This is particularly important in establishing the significance of a failure. For example, the failure of a capacitor in a reliability growth test becomes more significant if the database shows similar failures during incoming inspection of the part and in any environmental tests performed. For this reason all available sources of data should feed the FRACAS.

The Contractor shall maintain the failure database throughout the execution of the Works. The FRACAS system along with the database shall be handed over to the Employer at the expiry of the Defects Liability Period.

12.10 Field Testing and Integrated System Testing

12.10.1 General Requirements

12.10.2 The On-site Testing and Integrated System Testing shall demonstrate as a minimum the following requirements:

(1) That the safety management organisation to control the on-site Testing and Integrated System Testing is in place.

(2) The testing procedures shall ensure that all the critical failure modes as identified during the FMECA / FMEA activity are addressed through proper test cases inclusion. A traceability matrix shall be developed such that these critical failure modes are traced back to the corresponding test cases. All failure modes shall be considered as critical failure modes unless the Contractor demonstrates by a sensitive analysis or other means that the impact of a failure mode on reliability and maintainability will be insignificant.

(3) That the scope of activities to be carried out during the on-site Testing and Integrated System Testing period covers all Safety Critical functions and Safety requirements including those in the Hazard Log.

(4) That the segregation of on-site Testing and Integrated System Testing activities from residual construction and installation activities shall be implemented.

(5) That the procedures required to conduct on-site Testing and Integrated System Testing activities safely, including where necessary, the protection measures for any part of the Railway which may be in operation shall be implemented.

(6) That the processes which are to be implemented to validate the Safety Critical aspects of software installation and testing shall be implemented.

(7) That the processes required to assess the safety implications of the results of tests and inspections carried out during the periods of on-site Testing and Integrated System Testing activities shall be implemented.

(8) That the processes required to control and validate the safety implications of modifications carried out during the period of on-site Testing and Integrated System Testing activities shall be implemented.

(9) That the arrangements which are to be utilised to record, report and investigate accidents and incidents together with the systems necessary to formulate and implement measures to prevent reoccurrence shall be implemented.

(10) That effective controls shall be implemented in respect of the activities of all other contractors, relevant authorities and third parties.

12.11 Engineering Safety Validation Plan

12.11.1 Testing shall validate that all safety related functions have been implemented in accordance with the Detailed Design and the safety requirements identified in the Design Safety Report.

12.11.2 A programme of all safety validations to be carried out shall be submitted and this programme shall be updated with actual dates of validation during the on-site testing and integrated system testing phase.

12.11.3 Validation of the correct implementation of all safety design criteria shall be demonstrated by submitting details including:

(1) a cross reference to the programme of safety validations;
(2) the purpose of each validation;
(3) the method of each validation;
(4) the qualifications of staff performing the validation;
(5) the names of witnesses to the validation;

(6) the acceptance criteria for each validation;
(7) the results of each validation;
(8) analysis of validation results to show that they confirm requirements have been met; and
(9) the recommended procedure for the correction of deficiencies observed during the validation process and the steps required to repeat the validation.

12.12 Operational Safety Case

12.12.1 **General Requirements**

In order to demonstrate that the system will be managed safely, the Contractor shall produce and maintain an Operational Safety Case, in accordance with the System Assurance requirements detailed in the Contract documents.

12.12.2 The Operational Safety Case shall typically consist of but not be limited to the following:

(1) Executive Summary;
(2) Introduction;
(3) Definition of System;
(4) Quality Management Report;
(5) Safety Management Report;
  (a) Introduction;
  (b) Roles and Responsibilities;
  (c) Safety Lifecycle;
  (d) Safety Requirements;
  (e) Safety Standards;
  (f) Safety Audit and Assessment;
  (g) Supplier Management;
  (h) Safety Controls;
  (i) Configuration Management; and
  (j) Project Safety Training.
(6) Technical Safety Report
  (a) Introduction;
  (b) Assurance of correct functional operation;
  (c) Effects of faults;
  (d) Operation with External Influences;
  (e) Safety-related application conditions;
  (f) Safety Qualification tests; and
  (g) Other Outstanding Safety Issues.
(7) Conclusion

12.12.3 As part of the Operational Safety Case development process, the Contractor shall ensure that plans and procedures as typically listed below will be in accordance with the Operational Safety Case requirements:

(1) System Management Plan;
(2) System Safety Plan;

(3) System Operating Safety Plan;
(4) System Operating Plan;
(5) System Assurance Plan;
(6) Emergency Preparedness and Fault Recovery Plan;
(7) Rules and Procedures;
(8) Indian Railways Rules and Procedures; and
(9) Health and Safety Regulations.

12.13 Proof of Safety

12.13.1 The "Proof of Safety" shall demonstrate that the Works are fit for the purpose of commencing Revenue Service. The "Proof of Safety" shall make traceable reference to system documentation that shall demonstrate as a minimum the following requirements have been met:

(1) That the Works have been manufactured, installed and tested up to an including Integrated System Testing in a manner to ensure that the Railway can be operated and maintained within the parameters of risk as approved in the "Design/Systems Safety Report" and that there are no outstanding safety issues.

(2) That the recommended safety performance criteria and safety thresholds for the safe operation and maintenance of the Works have been met.

(3) That the standards and specifications upon which the safe operation and maintenance of the Works are based have been met.

(4) That the safe systems of work, rules and procedures required to operate and maintain the Works within the defined parameters of risk as approved in the "Design/Systems Safety Report" have been verified.

12.14 Trial Running

12.14.1 **Activities**

The period of Trial Running shall include as a minimum the following activities:-

(1) Demonstration of system performance and adherence to timetables during Trial Run.

(2) Evaluation of the effectiveness of normal operating procedures including those that deal with minor disruptions and staff unavailability.

(3) Evaluation of the effectiveness of system fault reporting, fall back systems, operating procedures and maintenance responses in the event of a number of system failures and degraded operating scenarios by simulating such scenarios during simulated revenue service.

(4) Evaluation of the effectiveness of operating procedures and other incident management responses in the event of a serious incident including but not limited to fire by simulating such scenarios during simulated revenue service.

12.15 Revenue Service Running

12.15.1 **General Requirements**

The Contractor shall continue to implement system assurance activities during and after the transition to revenue service including, but not limited to, the following requirements.

(1) Revenue Service shall not commence until the “Proof of Safety” has received the approval of the Employer.

(2) During the Defects Notification Period, day to day monitoring of the RAM performance shall be carried out and the findings shall be used for recording of the RAM performance.

(3) In the event that a defect/failure shall arise, the Contractor shall provide full technical support in failure investigation and rectification.

(4) The Contractor shall employ suitable mechanisms and develop a suitable organization structure in conjunction with the Employer to support ongoing RAM activities.

(5) The Contractor shall provide support to the Operator to ensure that the documentation and processes defined in the Ongoing Management of Safety document have been fully assimilated into the Operator’s Safety Management System and organization.

End of Chapter-12

CHAPTER 13 – TRAINING

13.1 General

13.1.1 The Contractor shall provide comprehensive training to the Employer's Personnel in respect of design, system engineering, construction/ installation, assembly, configuration, operations, fault diagnosis and maintenance of the systems/sub-systems, provided under the Contract. The Contractor shall arrange Training at Manufacturing facilities as well as at site, as per the approved Training Plan.

13.1.2 All the training courses at manufacturing facilities shall be conducted during design period and completed before the commencement of installation.

13.1.3 The training at manufacturing facilities has the potential of imparting maximum benefit and shall cover all Signalling and Telecommunication equipment provided under the contract.

13.1.4 All the training courses at site shall be conducted during installation period and completed before the commencement of testing and commissioning.

13.1.5 The Contractor shall also arrange training at site for Employer's maintenance and Operating personnel and Key Instructors. The Contractor shall set up training class rooms near to site, where he shall provide competent training instructors, training manuals, all necessary aids and materials as required for all the training courses. The training courses shall cover working principles, installation, operation, fault diagnosis & maintenance of all major equipment and works engineered by the Contractor.

13.1.6 The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields. The training instructors shall be either the system designer or engineering staff of the Contractor, the Contractor's subcontractors or the equipment manufacturers. No Training instructor shall be deployed without prior approval of the Engineer. The training shall be in English and Hindi languages as required. The Training abroad shall, however be in English language only. All training material shall be provided in English. If requested by the Engineer, the training material shall be provided in Hindi also.

13.1.7 The Employer intend to create some 'Experts' of each sub-system/equipment who need to be intensively trained by the Contractor in all aspects (design, installation, testing and commissioning, fault finding etc.) of each sub-system/equipment, and train them to the level that they can even undertake customization of the sub system as required by the Employer from time to time in future. The Employer will nominate up to 5 persons for training in each sub system.

13.1.8 The Training Program shall enable the basic staff to operate service, enhance, maintain and interact with the hardware, software and firmware such that the systems and associated equipment will perform in accordance with the specifications of this contract.

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

13.1.10 The Contractor shall submit assessment reports on the performance of individual trainees to the Engineer. Training evaluation shall be required at regular intervals to monitor the progress and suitability of the training program. Items that require further information or tasks that require additional training or practice will be discussed between Engineer and the

contractor at the evaluation meetings. Such items or tasks must be appended to the training program,

13.1.11 The Contractor shall bear all the training costs except for allowances, hotel and travel expenses of the Employer's trainees. .

13.1.12 Throughout training program, the Engineer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

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

13.1.14 The Contractor shall provide full-time management, co-ordination and supervision of the entire training Program to ensure the continuity of classes and proper distribution of training materials and be responsible for interfacing with the instructors.

13.2 Scope of Training

13.2.1 Objective of Training is as follows:

(1) To enable the Employer's maintenance personnel to maintain the commissioned Signalling and Telecommunication systems;

(2) To enable the Employer's Operating personnel to become competent in operating the various systems/sub-systems at work site; and

(3) To enable the Employer's Key Instructors to become competent to deliver future courses to other employees of the Employer;

(4) The Training shall be imparted on various Sub-systems. Aspects covered shall include, but not be limited to the following:

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

(b) System engineering aspects including design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination.

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

(d) System operating and maintenance management procedures and

(e) Control and monitoring systems for each System.

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

13.3 Training Plan

13.3.1 Within six months after the Commencement Date of the Works, the Contractor shall submit a Training Plan to the Engineer for review.

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

(1) the program of the training courses at site and at manufacturing facilities;
(2) overview and description of objectives of each training course;
(3) the location where the training courses to be conducted;
(4) submission schedule of the training materials;
(5) set ups for practical exercises;
(6) the Contractor's training organisation chart, including the role and responsibilities of

individual key persons;

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

13.4 Training Courses for Signalling and Telecommunication Sub-systems

13.4.1 The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, firmware and software. Each Course shall be specific and shall consist of classroom, hands-on and/or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan. The Contractor shall develop detailed training modules based on information in the Operating and Maintenance manuals.

13.4.2 The technical training courses to the Employer's staff shall be programmed in phases with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the equipment which is the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Equipment with maximum effort being directed at instruction in the maintenance of the installations.

13.4.3 Training at site shall include operation courses and maintenance courses. The class will be of maximum of 30 trainees. The Contractor in consultation with Engineer and Employer shall determine the number of classes for each type of training course, within the provisions available in respective Particular Specification, to ensure the objectives of the course can be met.

13.4.4 **Training Courses for Operating Staff**

The Training courses for Operating personnel on Signalling and Telecommunication systems/sub-systems shall be developed to provide all necessary knowledge and skills that enable them to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the Training course shall include the following as minimum:

(1) Overview of the system/sub-system;
(2) Brief description the operational principles of the system/sub-systems;
(3) Operational features and functions;
(4) Familiarisation and use of all man-machine interfaces involved;
(5) Reading and interpretation of system status and alarm messages or indications;
(6) Normal operating procedures;
(7) Operating procedures under emergency situations; and
(8) Procedures for recovery from minor or simple faults.
(9) A comprehensive list of Dos and Don'ts shall be prepared and explained to the Operating personnel and also shall be prominently displayed at the stations.

13.4.5 **Training Courses for Maintenance Staff**

The Training courses for maintenance staff at site shall, as a minimum, impart the following techniques to maintenance staff of Employer of the appropriate grades:

(1) Planned maintenance and overhaul of all the railway systems/subsystems supplied, installed or modified under the Contract;

(2) Fault diagnosis and rectification techniques for the systems/subsystems including equipment supplied, installed or modified under the Contract. These shall be developed from the Contractor's previous experience with similar equipment and also from the fault tree analysis and other analysis carried out as part of the reliability engineering studies undertaken by the Contractor;
(3) Normal and degraded modes of operation of the S&T systems/subsystems including equipment supplied, installed or modified under the Contract;
(4) All rules, regulations, practices and procedures necessary for the safe and efficient operation of the S&T systems/subsystems supplied, installed or modified under the Contract; and
(5) All contingency plans necessary to recover speedily and safely from any mishaps or emergencies that may arise with the S&T systems/subsystems supplied, installed or modified under the Contract.

13.4.6 The Training in Operation and Maintenance shall enable trainees to obtain competence, including obtaining Competency Certificate from the competent authority.

13.4.7 The training courses for system engineers at manufacturing facilities shall be developed to provide all necessary knowledge and skills to perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits.

13.4.8 The Contractor shall determine the content of the system engineering courses, however the courses shall include the following as minimum:

(1) Overview of the S&T systems/subsystems;
(2) Brief description of the operation principles of the Subsystems and background theory;
(3) System/ operational features and functions;
(4) Description of system components and equipment down to card or module level;
(5) Test and commissioning procedures;
(6) Use of test equipment and special tools;
(7) Reading and interpretation of alarm indications, messages and print-outs;
(8) Preventive maintenance procedures;
(9) Fault diagnosis, troubleshooting and corrective maintenance procedures;
(10) Equipment settings and parameters configuration;
(11) Use of Equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;
(12) Methods and procedures to provide new circuits, system expansion and enhancement;
(13) Data, software backup and loading;
(14) Use of software such as peripheral control and configuration, utility, database structure, generation and modification;
(15) Periodical Maintenance schedules and impacts;
(16) Familiarisation and use of all man-machine interfaces involved;
(17) Normal operating procedures;
(18) Operating procedures under emergency situations; and
(19) Procedures for recovery from faults

13.4.9 During the Defects Notification Period, when the Contractor is responsible for fault finding and repair, he shall provide practical hands on training to Employer maintenance staff to

facilitate successful handing over of the works.

13.4.10 **Training Courses for Signalling Sub Systems**

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

(1) Electronic Interlocking (EI).
(2) Power Supply System (Auto changeover, IPS/UPS, Batteries etc.)
(3) Multi Section Digital Axle Counters (MSDAC) and Single section Digital Axle Counters (SSDAC).
(4) Train Management System (TMS).
(5) Point machines.
(6) Earthing and Surge Protection Systems.
(7) Electric Lifting Barriers
(8) The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

13.4.11 **Training Courses for Telecom Sub Systems**

The Maintenance & Troubleshooting courses shall be developed to provide all necessary knowledge and skills for maintenance staff of the Employer to perform full maintenance, including both preventive and corrective maintenance and fault diagnosis in case of failure.

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

(1) Optical Fiber Cable communication system;
(2) Data Networking system;
(3) Telephone Exchanges and associated sub-systems;
(4) Mobile Train Radio communication system;
(5) VHF system;
(6) Master Clock system;
(7) Earthing and Surge Protection Systems;
(8) Video Surveillance system; and
(9) Power Supply System

The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

13.5 Training material and Equipment

13.5.1 The Contractor shall provide such written or printed matter, functional equipment, samples, models, cutaway equipment, slides, films and other instructional material, as may be necessary for training. Such equipment and material shall remain the property of the Employer and shall be sufficient both for the persons trained by the Contractor and for those to be subsequently trained by Employer Training Instructors.

13.5.2 The Contractor shall arrange all training material including tables, chairs, white boards, and so on. If available, the Contractor may however, use the training rooms of the Employer.

13.5.3 With the prior approval of the Engineer, the Contractor may use the Works being erected,

tested or commissioned for the training of Employer Personnel.

13.5.4 The Contractor shall prepare a Trainer's guide for each training course. The Trainer's guide shall include the course agenda, objectives, list of resources and facilities required, detailed lesson plans, presentation notes, discussion guides, training aids and job aids, test papers, criteria and methodology for testing and assessment, and all other things that will enable Employer's Training Instructors to carry out repeat or refresher courses in the future.

13.5.5 At the commencement of the training course, the Contractor shall, distribute two sets of Trainer's guides and one set of Training manual for each trainee and two sets of Trainer's guides and three additional sets of Training manual to the Engineer

13.5.6 Training course notes shall be compatible and where appropriate, cross-referenced to the Manuals supplied by the Contractor as part of the Operation and Maintenance documentation.

13.5.7 The Training course notes and Trainer's guides shall be submitted to the Engineer for review six (06) months prior to the commencement of the first training session of the course. Course notes and Trainer's guides shall be in a standard format as decided by the Engineer and in a form that allows for easy reproduction. At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form allow easy future reproduction.

13.6 Test and Assessment

13.6.1 The Contractor shall develop a system of assessment and certification of trainees at the end of each course. The system of assessment shall test the knowledge, understanding and proficiency of the trainees.

13.6.2 The assessment and certification procedures shall be submitted by the Contractor for approval of the Engineer.

13.6.3 At the end of the training period, the Contractor shall issue Training certificate to the trainees who pass the assessment.

13.6.4 Training sessions, tests, and certification processes may be witnessed by the Engineer and the Employer.

13.6.5 The Contractor in consultation with the Engineer, shall develop a system of Feedback after each Training course. The Feedback forms shall measure the Trainee's level of satisfaction with the course content. The Feedback form shall be submitted to the Engineer for review four weeks before the commencement of the Training course.

13.7 Training Records

13.7.1 The Contractor shall keep attendance records of trainees.

13.7.2 The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.

13.7.3 The Contractor shall, at the completion of each training course provide the Engineer a consolidated training records listing the training course title, date of training, name of all trainees, training result and other relevant information.

13.7.4 After two weeks, the Contractor shall submit a Training report to the Engineer for review.

The Training report shall include a summary of the training course conducted, the results of trainees' assessment and the Feedback report.

End of Chapter-13

CHAPTER 14 – OPERATION & MAINTENANCE AND SERVICE LIFE SUPPORT

14.1 General

14.1.1 Operation and Maintenance is an important element in the execution of a project. It is essential to have a well-designed Operation & Maintenance Support Plan and Maintenance Plan before the system is made Operational. These plans shall be submitted to Engineer for review, at least six months before start of Defect Notification Period.

14.1.2 It shall be ensured that the resource requirement in terms of men and material as identified in the Plans is available before the system is made Operational.

14.1.3 The Contractor shall repair and/or replace, in each case at no cost to the Employer, any part of the Works which is found to be defective by reason of faulty design, materials or workmanship or negligence or failure on the part of the Contractor to comply with any obligation expressed or implied under the Contract, during the DNP after the date of issue of the Taking Over Certificate of the Works. The Works shall include equipment being provided under Contract Package CP-104 and upgraded/augmented/reconfigured, under this Contract.

14.1.4 During the Defects Notification Period, as a result of an inspection made by or on behalf of the Employer at any time or times prior to its expiration, the Engineer shall have the right but not the obligation to instruct the Contractor in writing to execute all such work of repair, amendment, rectification and make good defects, imperfections or other faults in the Works and any part thereof, as the case may be.

14.2 Operation and Maintenance Support Plan

14.2.1 Operation and Maintenance Support Plan shall cover, but not limited to, the following items:

(1) Submission of Technical Manuals as required for both Signalling and Telecommunication;
(2) Submission of Operation & Maintenance Manuals for each item/unit/ equipment;
(3) Requirement of Employer's Manpower for maintenance;
(4) Proposed Contractor's Manpower for supervision of Maintenance during Defect Notification Period;
(5) Provision of Software support during Defect Notification Period;
(6) Provision of Spares, Test Equipment, Tools, etc. for respective equipment and machines;
(7) Requirement of periodic operation of equipment and machines which would otherwise deteriorate because of non-operation for extended periods.

14.3 Support during Defect Notification Period (DNP)

14.3.1 Support and Call-out Services

(1) The Contractor shall provide the Support & Call-out-services for maintenance of the system. The maintenance will be done by the Employer with the support of the Contractor. The Support and Call-out services shall be available 24 hours per day and 7 days per week.

(2) The Contractor shall deploy adequate, committed and competent resources for providing desired level Support and Call-out-services. As a minimum, the expert of each sub-system of Signalling and Telecommunication shall be provided by the contractor at every IMD/IMSD location. All the resources shall be trained before deployment.

(2) The resource deployment shall be as per Operation and Maintenance Support Plan approved by the Engineer. The Contractor shall provide a list of staff together with the contact landline/mobile telephone numbers who can be contacted for Support and Call-out-services. Any change in the staff or his call-out number shall be notified to the Engineer at least two weeks before such change becomes effective.

(3) The Contractor's response Time for Support & Call-Out-Services shall not exceed one hour for Signalling and two hours for Telecommunication. The Response Time is defined as the time that elapses between the reporting of a fault and the Contractor's Call out personnel arriving at site where the faulty equipment is located.

(4) In case of any abnormal System behavior like intermittent faults, interference, frequent repeated faults, etc. occur or the performance is found to deviate from the specified tolerances, the Contractor shall conduct investigations and report the findings to the Engineer along with the recommendations and proceed after the recommendation has been reviewed without objection by the Engineer. The Contractor shall take every precaution to protect existing equipment from damage and make good any damage caused.

14.3.2 Workshop Repair

(1) The Contractor shall provide Workshop repair services for all defective and faulty items of the System and shall collect and repair defective parts that are removed from the System during corrective and predictive maintenance.

(2) The Contractor shall perform all necessary adjustments or alignments as required to the repaired parts. The repair of defective parts can only be considered as completed and returned to stock or back to the System if the parts are tested and verified fit for use in the System.

(3) The Contractor shall use only components of equal or better specification than the original components in his repair activities. The performance of the defective parts after repair shall not be degraded or deteriorated due to repairs.

(4) The maximum turnaround time for workshop repair shall be less than 28 calendar days. The turnaround time count shall start from the time the defective parts are removed from the System and shall continue till the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

14.4 RAMS Targets Failures

14.4.1 In case of failure of the Contractor to achieve the RAMS Targets specified in the Employer Requirement:

(1) The Defects Notification Period shall stand extended for a further period corresponding to period of failure;

(2) The Performance Guarantee shall stand extended for a period corresponding to the

extension of the Defects Notification Period; and

(3) All work required to be carried out by the Contractor for the rectification of defects, shall be carried out at the Contractor's own expense.

14.5 Operation and Maintenance Manuals

14.5.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of systems, the Contractor shall produce manuals covering the additional provisions, over and above the various existing Codes and Manuals of Indian Railways in respect of the Operation and Maintenance requirements of various assets created under the Contract.

14.5.2 With reference to the requirements as above, the Contractor shall produce manuals for all equipment and manufactured items and sub-systems, supplied and created under the Contract, for their efficient operations and maintenance. These shall include, but not be limited to, the following equipment/sub-systems:

(1) **Maintenance of Signalling Equipment:**

(a) Electronic Interlocking System
(b) Point Machines
(c) Track Vacancy Detection System
(d) Power Supply System for Signalling
(e) Signalling cables
(f) Earthing, Lightning and Surge Protection System
(g) Service and Diagnostic System
(h) Data Logger System for Event Logging and Predictive Maintenance

(2) **Maintenance of Train Management System:**

(a) Interface equipment for transfer of data
(b) Video Wall Display system in OCC
(c) Automatic Train Charting

(3) **Maintenance of Telecommunication Equipment:**

(a) Optic Fiber Cable Communication System
(b) Data Networking System
(c) Telephone System
(d) Mobile Train Radio Communication System
(e) Master Clock System
(f) VHF Communication System
(g) Earthing, Lightning and Surge Protection System
(h) Emergency Communication System
(i) Control Office Equipment for Train Dispatch
(j) Power Supply System for Telecommunication

(4) System/Sub-System Manuals- A comprehensive description of all system principles at block diagram level.

(5) Operating/User Manuals - broken into as many sub-sections as necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system. The Operating Manual of EI shall contain detailed description of all the operations of the SM's Control terminal with coloured illustrations.

(6) Workshop Manuals - Installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction/installation drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

(7) Software System Manual - for each software package and each piece of equipment which incorporates Programmable Device(s), licensed copies of CD/DVD of application and peripheral software along with write up on software features, instructions for configuration, working of software and procedures for taking out report and data in the form of instruction manual/guide.

14.6 Maintenance Plan

14.6.1 While Operation & Maintenance Support Plan take care of day to day operation and maintenance of the systems/sub-systems, the Maintenance Plan is designed to put the maintenance practices on sound footing for proper upkeep of the systems. The Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for review at least 12 months before start of Defect Notification Period.

14.6.2 The Maintenance Plan shall describe, but not limited to, the following:

(1) Maintenance philosophy and approach,
(2) All necessary tasks for first line, second line, third line and corrective maintenance,
(3) Frequency of each maintenance task,
(4) Employer's and Contractor's proposed maintenance regime for maintenance,
(5) Maintenance Schedules (Daily, Weekly, Monthly) detailing maintenance task for each maintenance team member;

14.6.3 The Maintenance Plan shall be aligned with the Employer's maintenance policy.

14.7 Maintenance Schedules

14.7.1 The Contractor shall prepare the Maintenance schedule for each item/equipment required to be maintained. The schedule should give the details such as the frequency of maintenance, the items to be maintained, the tolerances permitted and the safety checks to be performed. The Contractor shall submit the Maintenance Schedule to the Engineer for review.

14.7.2 In addition to the above, the Contractor shall include in the Maintenance Schedule the following information:

(1) The equipment, sub-systems covered in the task,
(2) Step by step procedure to carry out the task,
(3) Tools and test equipment required for each task,
(4) Diagrams and flowcharts by illustration, if applicable,
(5) Adjustment procedures for all field adjustable units,
(6) Recovery procedures, if applicable,
(7) Precautions to be followed by maintenance personnel and
(8) Estimated duration and manpower required;

14.8 Maintenance Manual

14.8.1 The maintenance manual shall contain the following, but not limited to:

(1) Technical description of each system and sub-system of equipment installed to ensure that the Employer's technical staff fully understand the scope and facilities provided.

(2) Diagrammatic drawings of each system indicating principal components and items of equipment

(3) Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment.

(4) Manufacturer's service manual for each major item of equipment, assembled specifically for the project including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance Program.

(5) Procedures for fault location and isolation.

(6) Maintenance procedures and their periodicity. The contractor must give list of Items to be checked, adjustments to be made, safety checks to be performed and frequency of maintenance for each item of the sub-system/equipment. These maintenance Schedules should be compiled in the form of a register and shall be kept at stations for recording of the maintenance done by Signal maintainer. It should lead to computerization of the maintenance activities.

(7) Tools and Plant needed for maintenance of different Equipment provided in the Works.

(8) Configuration Manual for all equipment, wherever required.

(a) All test results conducted on the relevant equipment whether at the manufacturer's place or at site; and

(b) Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items, which may involve extended deliveries.

(9) The Contractor shall submit all the Manuals for review by the Engineer prior to Factory Acceptance Tests which shall be submitted not later than 112 days from the targeted date of start of Trial Running for the Engineer's consent.

(10) The Contractor shall provide sufficient copies of all Manuals along with electronic version for use of the Employer's Staff/Engineer.

(11) The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period, wherever applicable.

14.9 Software Support

14.9.1 The Contractor shall submit a Software Support Plan at least ninety (90) days before commencement of Software installation. This plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments and new versions of the program as required by the Engineer.

14.9.2 The changes and modifications of the software shall not degrade the performance or have adverse impact on the system. The Contractor shall maintain backup copies of all software developed or delivered for the System.

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

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

14.9.5 The Contractor shall provide full support to the Employer and Engineer for all computer programs provided by the Contractor under the Contract.

14.9.6 The Contractor shall provide all tools, equipment, manuals, configuration and customization data and training necessary for the Employer's staff to maintain and re-configure all the software provided under the Contract. This shall include supply of any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

14.9.7 The Contractor shall submit all new versions to the Engineer for review at least two (02) weeks prior to their installation. New Versions of any program shall not result in any non-conformance with the Specification or degrade the performance or have adverse impact on the System. The Contractor shall:

(1) ensure that all new versions are fully tested and validated on the simulation and development system prior to installation;

(2) ensure that all new versions are fully tested and commissioned once installed on the site; and

(3) deliver to the Employer any new version, together with the updated Operation and Maintenance Manuals.

(4) All new version of software shall be accompanied by a release note containing the following details:

(a) Version number
(b) modifications made to the previous version;
(c) check sum

14.9.8 The Engineer shall not be obliged to use any new version that shall not relieve the Contractor of any of its obligations. Any effect upon the performance or operation of the computer-controlled system that may be caused by a new version shall be brought to the Engineer attention including updating the files to suit new version.

14.9.9 Security obligations

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

(1) All source and executable code including all data configuration tables.
(2) All design documentation relating to the software;
(3) Any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers, and
(4) All licenses in favour of the Employer for their perpetual use by DFCCIL for the entire life of the systems.

14.10 Monthly Maintenance Meeting

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

14.11 Service Life support

14.11.1 The Contractor shall ensure availability of full support to the Employer during the Service life of the project, for operation, maintenance, customization and upgradation of system/sub-

system supplied and installed by him as part of the Contract. Wherever the equipment provided under Contract Package CP-104 are being upgraded/augmented/reconfigured under this Contract, this support during service life for operation, maintenance, customization and upgradation shall be available for these equipment.

14.11.2 The contractor shall ensure that the OEM should either provide support as above on his own or sign an MOU with suitable Indian companies or company having proven track record and are working in related areas for all systems/subsystems. The copy of the MOU shall be submitted to the Employer as a proof of continuous support.

14.11.3 The Contractor/OEM of the system/subsystem may be required to undertake comprehensive Annual Repair Contract (ARC) at the end of Defect Notification Period. The comprehensive ARC may include supply of cards/modules for repairs/replacement of the sub system/system. However, this ARC will be a separate contract and will not be part of this Contract.

14.11.4 The Contractor must ensure the following, but not limited to :

(1) Availability/Establishment of repair/servicing facility in India. The Local Service Centre shall have test and repair facility with simulation test set-up, fault diagnostic system, test jigs, software for testing of cards/modules along with required test instruments and tools.
(2) Availability/Establishment of Organization in India that can enter into Annual Maintenance Contract (AMC) with the Employer.
(3) Availability/Establishment of Customization facility to add/modify/re-engineer hardware/software of the subsystem as required by the Employer during the lifetime of the equipment for adding facilities/features with future yard modification/signalling equipment up gradation etc.
(4) Supply of Spares for entire Service life of the equipment.
(5) Supply additional equipment required for replacement or expansion of the network in future.
(6) Training of Employer's Personnel in Operation and maintenance of existing and new/modified equipment/sub-systems.

14.11.5 The sub systems/systems of OEMs who are for complete Transfer of Technology (TOT) including system assembly, manufacturing, installation, maintenance and software modification/customization, training etc. shall be preferred for use by the Employer. In such case, the Contractor shall submit the detailed plan for progressive manufacture of imported items by OEM in India.

End of Chapter-14

ANNEXURE-1

LIST OF LEVEL CROSSINGS TO BE RETAINED

S.N.	Station Name	Sub Section Name	Chainage of LC gate	LC. No.	Existing IR Block Section
1	Mughalsarai		127886	112C	Mughal Sarai Yard
2		Mughalsarai-New Ahraura Road	129597	113-C	BH/K Yard (Jeonathpur)
3		Mughalsarai-New Ahraura Road	132962	114-C	Jeonathpur Yard
4		New Mirjapur-New Unchdih	202500	10-A	Vindhyachal Yard
5		New Mirjapur-New Unchdih	226681	17-C	BH/JJ-Manda Road
6		New Mirjapur-New Unchdih	233290	20-C	Block Hut 'QQ' Yard
7		New Unchdih-New Karchna Jn.	240545	23-C	Unchdih - Meja Road
8		New Unchdih-New Karchna Jn.	247465	26-C	Meja Road -BH/C
9		New Unchdih-New Karchna Jn.	256095	27-C	Bheerpur Yard
10		New Unchdih-New Karchna Jn.	259685	29-B	Bheerpur - BH/B
11		New Unchdih-New Karchna Jn.	264280	30-B	BH/B-Karchna
12		New Karchna Jn.-New Manauri	1343/5	431-C/2E	Iradatganj - Karchana
13		New Manauri-New Sujatpur	298750	6B	Manauri-Saiyed Sarawan
14		New Manauri-New Sujatpur	316082	12C	Manoharganj - Bharwari
15		New Sujatpur-New Rasulabad	336412	18C	BH/KK-Sirathu
16		New Rasulabad-New Malwan	380154	42B	Satnaraini-Rasulabad
17		New Malwan-New Kanpur	448224	67C	Karbigwan-Prempur
18	New Bhimsen		1334/0-1/IR	236	New Bhimsen - Bhimsen

NOTE: This list of Level Crossing Gates is indicative. Although the total number of LC Gates will remain 18, however their location, chainage and LC No. may change during design stage.

End of Annexure 1

ANNEXURE-2

Employer has acquired land for TSSs, SPs and SSPs shown in Table 1, 2 and 3. These locations are tentative and may change during execution of Contract Package-204.

Table 1 List of Proposed Traction Substations (TSS)

S. No.	Installation Name	IR Chainages including detour (KMs)	DFCC Chainage (in Km)
1	Deoria TSS	681	133.4
2	Chandai Pur TSS	Detour	194.2
3	Gadhiaw TSS	800/21-25	258.1
4	Bharwari TSS	861.5	317.051
5	New Rasulabad TSS	920	379.363
6	Aung TSS	980.3	442.395
7	Piturpur TSS	Detour	501.773

Table 2 List of Proposed Sectioning and Paralleling Posts (SP)

S.No	Installation Name	IR Chainages including detour (KMs)/location	DFCC Chainage (in Km)
1	Newaria SP	712/17-19	164.91
2	Kukhuri SP	767/21-23	225.533
3	Subedar Ganj SP	Detour	288.205
4	Athsarai SP	889/15-19	347.739
5	Kurasati Kalan SP	951/5-7	413.341
6	Chakeri SP	Detour	472.071

Table 3 List of Proposed Sub Sectioning and Paralleling Posts (SSP) (Mid Section)

S.No	Installation Name	IR Chainages including detour (KMs)/location	DFCC Chainage (in Km)
1	Nakhra SSP	696/23-25	149.155
2.	Adhwar SSP	Detour	179.555
3	Birohi SSP	751/25-27	209.867
4	Kotha SSP	783/25-27	241.817
5	Chheoki SSP	Detour	269.09
6	New Manauri SSP	847	302.565
7	New Shujatpur SSP	877	332.483
8	Khaga SSP	905/1-3	363.202
9	Ramwa SSP	935	396.717
10	New Malwan SSP	966-67	428.604
11	New Kanpur SSP	997.76	459.714
12	Bhimsen SSP	Detour	488.424

End of Annexure 2

ANNEXURE-3

MONTHLY PROGRESS REPORTS

1 GENERAL

(1) The Contractor shall submit to the Engineer, a monthly progress report in accordance with the Conditions of Contract.

(2) This Report shall be submitted not later than the 7th day of each calendar month and shall account for all work actually performed during the previous calendar month.

(3) It shall be submitted in English in five hard copies and one copy in electronic storage device.

(4) It shall be submitted in a format agreed to by the Engineer and shall contain sections/sub-sections for, but not be limited to the topics listed in Clauses 2 to 10 below.

(5) The results of quality audits shall be summarised in the Contractor's monthly reports.

2 SAFETY

(1) A review of all safety aspects during the month including reports on all accidents and actions proposed to prevent further occurrence including details of safety training and drive conducted during the period and proposed in coming months. This shall be the first item of Monthly Progress Report.

3 FINANCIAL STATUS

(1) A narrative review of all significant financial matters and actions proposed or taken in respect of any outstanding matters.

(2) A spread sheet indicating the status of all payments due and made including recoveries, if any.

(3) A report of the status of any outstanding claims to be submitted, even if there is no outstanding claim.

(4) The report shall in particular provide interim updated accounts of continuing claims.

4 PHYSICAL PROGRESS

(1) It shall describe the status of work performed in detail, significant accomplishments, including critical items and problem areas. This report should include current and anticipated delaying factors and their impact, corrective actions taken or planned. Any other pertinent activity and shall, in particular, address interface issues with all agencies involved, problems and resolutions during the period or anticipated.

(2) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Program.

5 PROGRAM UPDATE FOR ENTIRE PROJECT

(1) Program updating shall include:

(a) The monthly program update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the last day of the month and expected activity completion based on current progress.

(b) The Program update shall be accompanied by an activity report and a narrative statement.

(c) The narrative statement shall explain the basis of the Contractor's submittal:

(i) Early Work and baseline submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Milestones as specified in Chapter-3 - Project Program Requirements.

(ii) Updated detail program submitted shall state in the narrative form about the Works actually completed and reflected along critical path in terms of days ahead or behind allowable dates. The specific requirements of narrative are:

- If the updated detailed work program indicates an actual or potential delay to Contract Completion date or Milestones, identify causes of delays and provide explanation of work affected and proposed corrective action to meet Milestones or to mitigate potential delays.
- Identification of any deviation from previous month's critical path.
- Identify by activity number and description, activities in progress and activities scheduled to be completed.
- Discuss variation work order items, Value Engineering items, if any.

(d) Program Status which shall:

(i) Show Works Program status up to and including the current report period, display cumulative progress to date and a forecast of remaining work.

(ii) Be presented as a bar-chart in size A3 or A4.

(e) The activity variance analysis which shall analyze activities planned to be started prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Program.

6 PLANNING AND CO-ORDINATION

(1) A summary of all planning/co-ordination activities during the month and details of outstanding actions.

(2) A schedule of all submissions and consents/approvals obtained/outstanding.

7 PROCUREMENT REPORT

(1) A summary of all significant procurement activities during the month, including action taken to overcome problems.

(2) A report listing major items of plant and material which will be incorporated into the Works.

(3) The items shall be segregated by type and the report should show as a minimum the following activities:

(a) Purchase order date - scheduled/actual;

(b) Manufacturer/supplier and origin;

(c) Letter of credit issued date;

(d) Manufacturer/supplier ship date - scheduled/actual;
(e) Method of shipment;
(f) Arrival date in India- scheduled/actual.

8 PRODUCTION AND TESTING

(1) A review of all production and manufacturing activities during the month.
(2) Summaries of all production and manufacturing outputs during the month together with forecasts for the next month.
(3) Review of all testing activities (both at Site and at the manufacture's premises) during the month

9 DEPLOYMENT OF MANPOWER MATERIAL AND EQUIPMENT AT SITE

(1) Detail showing the extent of deployment of manpower, equipment and stock of important construction material utilized at the Site.
(2) A list of major construction equipment used on the Project during the reporting period and any construction equipment idle during the reporting period.
(3) A list of all major or critical material and equipment, indicating current availability and anticipated job Site delivery dates.
(4) The total number of personnel by craft actually engaged in the work during the reporting period, defined separately as to office, supervisory, and field personnel.
(5) A manpower and equipment forecast for the upcoming twenty eight (28) days, stating the total number of personnel by craft, defined separately as to office, supervisory and field personnel.
(6) Changes or additions to Contractor's supervisory personnel that occurred from the preceding Monthly Progress Report. The Monthly Progress Report shall accompany the Application for Payment and monthly schedule update.

****End of Annexure 3****

ANNEXURE-4

DESIGN CERTIFICATE

This Design Certificate refers to Submission No. ..…… ……which comprises:

[*Design Package No. .... / the Detailed Design and Drawing Submission No. .... / Technical Submission No. ....] in respect of:

[description of the Works to which the submission refers]

The contents of this submission are scheduled in Section A below.

The documents scheduled in Section B below, for which a Notice of No Objection has been issued, are of relevance to this submission.

DESIGNER'S STATEMENT

We hereby certify that:

a) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the specifications requirements and ..... [see note 1 below];

b) The outline designs, design briefs and performance specifications of those elements of the Works as illustrated and described in the documents scheduled in Section A below comply with the specifications requirements and ..... *[see note 1 below]*;

c) The design of the Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements specifications requirements and..... *[see note 1 below]* except in the following respects:

    (i) ..... (to be completed by Contractor/Designer)

    (ii) ..… (etc.)

d) An in-house check has been undertaken and completed to confirm the completeness, adequacy and validity of the design of the Works as illustrated and described in the documents scheduled in Section A below;

e) All necessary and required approvals relating to the design of the Works, as illustrated and described in the documents scheduled in Section A below, have been obtained and copies of such approvals are annexed in Section C below;

AND (in the case of a submission covering a part of the Works only) :

f) All effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of those parts.

Signed by 'Authorized Representative'

(for Designer)

Name

Position/ Designation

Date

CONTRACTOR'S CERTIFICATION

This is to certify that all design has been performed utilizing the skill and care to be expected of a professionally qualified, competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us.

Signed by 'Authorized Representative' (for Contractor)

Name

Position/Designation

Date

Note 1

The Contractor shall insert one of the following, as applicable:

(i) the Contractor's Technical Proposals

(ii) the Contractor's Technical Proposals and Design Packages Nos. ..... for which a Notice of No Objection has been issued.

(iii) Design Packages Nos. ..... for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Detailed Design:

Section A

Submission no. .... comprises the following :

Drawings : *(Title, drawing number and revision)*

Documents: *(Title, reference number and revision)*

Others:

Section B

Documents for which a Notice of No Objection has been issued and which are of relevance to this Submission No. .....

Document:

Submitted with

[*Design Package No. ..……./ Detailed Design Submission No……./ Good for Construction Drawing Submission No. ..../ Technical Submission No. ..……./ Date of Issue of Notice of No Objection	*The Contractor is required to provide this information in respect of each document in Section B*

(Delete as appropriate)*

Section C

[Contractor to attach copies of necessary and required approvals]

End of Annexure 4

ANNEXURE-5

Drawings and CAD Standards

1 Purpose

(1) The purpose of this section is to define the minimum Drawings and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the Works.

(2) By defining a common format for the presentation of Drawings and CAD files, the exchange of drawn information is improved and will maximize the use of CAD in the co-ordination process.

(3) All submissions shall be made to the Engineer's requirement in a format reviewed without objection by the Engineer in accordance with the requirements in the Contract;

(4) Paper and drawing sizes shall be "A" series sheets as specified in ISO 5457.

(5) The following software compatible for use with Intel-Windows based computers shall be used unless otherwise stated, for the various electronic submissions required:

Document Type	Electronic Document Format
Auto CAD Graphics	CorelDraw, Ver. 12.0/ AutoCAD 2011 or latest versions
Photographic	Adobe Photoshop CS2 or latest version
Desktop Publishing	Page Maker 7.0 or latest version
CAD Drawings	AutoCAD 2011 or latest version.

(6) For electronic file submission one copy shall be submitted unless otherwise stated on CD-ROM media. The media shall be CD-R and the recording method shall not allow any further changes to the recordable disk.

(7) Internet File Formats/Standards:

The following guidelines shall be followed when the Contractor uses an internet browser as the communication media to share information with the Engineer /Employer.

All the data formats or standards must be supported by Microsoft Internet Explorer version 7 or above running on Windows XP or above.

The following lists the file types and the corresponding data formats to be used on internet. The Contractor shall comply with them unless prior consent is obtained from the Engineer for a different data format:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF or JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM) and DWG
Video	Window video (.avi)
Sound	Wave file (.wav)

(8) The following states the standards to be used on the internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained from the Engineer for a different standard:

Function to be implemented	Standard to be complied with
Database connectivity	Open Data Base Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hyper Text Markup Language (HTML)

2 General Requirements

(1) The Contractor shall adopt a title block similar to that used in the drawings for all the Contractor's documents prepared under the Contract.

(2) Each document shall be uniquely referenced by a document number and shall define both the current status and revision of the drawing.

(3) The current status of each document shall be clearly defined by the use of a single letter code as follows:

- A single letter character denoting the status of the drawings

  T Tender Design
  W Working Drawing
  M Manufacturing Drawing
  S Site Drawing
  D Shop Drawing
  A As Built Document

- A single digit code denoting the contract number (for the whole line)

  1 Design
  2 Civil / Track Works
  3 Electrification Works
  4. Signalling Works
  5. Telecommunication Works

- A two (2) letter code denoting the type of System Works or system elements

  CG General Works

  ST Stations

  TU Tunnels (if any)

  AL Alignment

  RW Right - Of - Way

  CE Civil Engineering (earth work, culverts, pedestrians, foot bridge, agricultural underpass, survey, track drainage, etc.)

  RB Railway Bridges

  ROB Road Over Bridges

  RUB Road Under Bridges

  EC Environmental Control System

  UT Utilities (Power, Gas, Telecoms, Electric, Water supply, Sewer lines)

SE Structural Engineering (structural steel, reinforced concrete etc.)

GE Geotechnical Engineering (Instrumentation, ground treatment, de-watering, etc.)

AR Architecture

LS Landscape

EE Electrical Engineering (low voltage)

ME Mechanical Engineering (ventilation, fire fighting, plumbing)

PS Power Supply (high voltage, traction power)

SG Signalling (train control)

CM Telecommunications System

TK Track-work

TM Traffic Management (Roads, Pavements)

WS Water Supply

SW Switching Stations

GS Grid Sub-station

TS Traction Sub-station

TL Transmission Line

SC SCADA system

- A unique four (4) digit number (from 0001 to 9999), identifying each drawing.
- A single letter (A to Z except I and O) denoting the sequence of revision of the drawing. The initial drawing issue will carry a revision letter "A".

Example: Drawing Title Block:

Status	Drawing No:	Revision:
D	1 / SG / 0235	B

(Note: The comparable computer reference is “1SG0235B”)

Denotes:

(D) Shop Drawing (1) Design (SG) Signalling (0235B) Drawing number 0235 Rev. B

3 Computer Aided Design and Drawings (CAD) Standards

(1) The production of all CAD data files shall comply with the applicable legislation in India, standards for the relevant issue and the requirements as defined hereinafter.

(2) The main objectives of the CAD standards are as follows:

- To ensure that the CAD data files produced for project are coordinated and referenced in a consistent manner.

- To provide the information and procedures necessary for a CAD user from one discipline or external organisation to access (and use as background reference), information from a CAD data file prepared by another discipline or external organisation.
- To standardize the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.
- To establish procedures necessary for the management of CAD data files.

3.1 To ensure all contractors use 'Model space' and 'Paper space' in the production of their CAD files.To facilitate co-ordination between contractors, it is a requirement that all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods.

3.2 The intent of the issue of digital information is to aid the interface design by others.

3.3 The definitive version of all Drawings shall always be the paper or polyester film copies which have been issued by the Contractor or organisation originating the drawing and also held in the Project's electronic document control system.

3.4 Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.

3.5 Any contractor or organisation making use of the CAD data from others shall be responsible for satisfying themselves that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which it is being used, provided the general principles of this section have been achieved by the originator of the CAD data.

3.6 In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings.

3.7 Figured dimensions shall always be taken as correct where discrepancies occur.

3.8 Terminology and Associated Standards

3.9 Any terminology used within this section that is ambiguous to the user shall be clarified with the Engineer. Indian national and Indian Railways standards are to be used in principle as a guide for drawing practice, convention, CAD data structure and translation.

4 Paper Drawings

4.1 For the Project "Paper" drawings are considered to be the main vehicle for the receipt and transmittal of design and production information, typically plans, elevations and sections.

4.2 CAD Quality Control

Random CAD Quality control audits will be carried out by Engineer on all CAD media received and transmitted.

4.3 These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organisation); however compliance with project CAD and Drawing Standards shall be checked.

4.4 In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place.

4.5 A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

4.6 CAD Data Transfer Media and Format

4.7 When CAD data is received and transmitted between the Engineer and the Contractor, the media shall be as follows:

4.8 All CD-R/RW and DVD+/-R must be labelled on the data shield with:

Name of Company
Project Title
Drawing Filenames
Disk No. / Total No. of disks

4.9 All media shall be submitted with a completed form (CAD Disk)

4.10 The CAD data file transmittal format required by from all contractors shall be in AutoCAD (version 2011) or latest version.

5 Revisions

5.1 The following details on the designs shall be located on a common layer, which can be turned on or off for plotting purposes.

(1) 'Revisions',
(2) 'In abeyance' and
(3) 'Deletions'

5.2 Block Libraries, Blocks and Names

5.3 All construction industry symbols produced as CAD Cells shall typically conform to Indian Standards.

5.4 All blocks created shall be primitive (i.e. NOT complex) and shall be placed absolute (i.e. NOT relative).

5.5 The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description.

5.6 The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

5.7 All blocks of a common type, symbols or details should initially be created within a CAD "Model Space File" specifically utilised for that purpose. These files will be made available on request by Engineer.

5.8 All blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each block's masked area or volume.

6 CAD Dimensioning

6.1 Automatic CAD Dimensioning will be used at all times.

6.2 Any dimensional change must involve the necessary revision to the model space file.

6.3 If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

6.4 CAD Layering

(1) All CAD elements shall be placed on the layers allocated for each different discipline.
(2) The Contractor's layer naming convention shall be submitted for the Engineer's approval.

6.5 Global Origin, Location And Orientation On The Alignment Drawings

6.6 Location or plan information in "Model Space" files shall coincide with the correct location and orientation on the project grid for each specific contract.

6.7 Location plans shall have at least three setting out points shown on each CAD "Model Space" file. Each setting out point shall be indicated by a simple cross-hair together with related Easting and Northings co-ordinates.

6.8 The Contractor shall establish the three setting out co-ordinates for their respective works which will then be used by the Contractor and the sub-contractor(s), if any.

6.9 Line Thickness and Colour

To assist plotting by other users, the following colour codes will be assigned to the following line thickness / pen sizes:

Colour	**Code No.**	**Line Thickness**
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

End of Annexure 5

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: 203

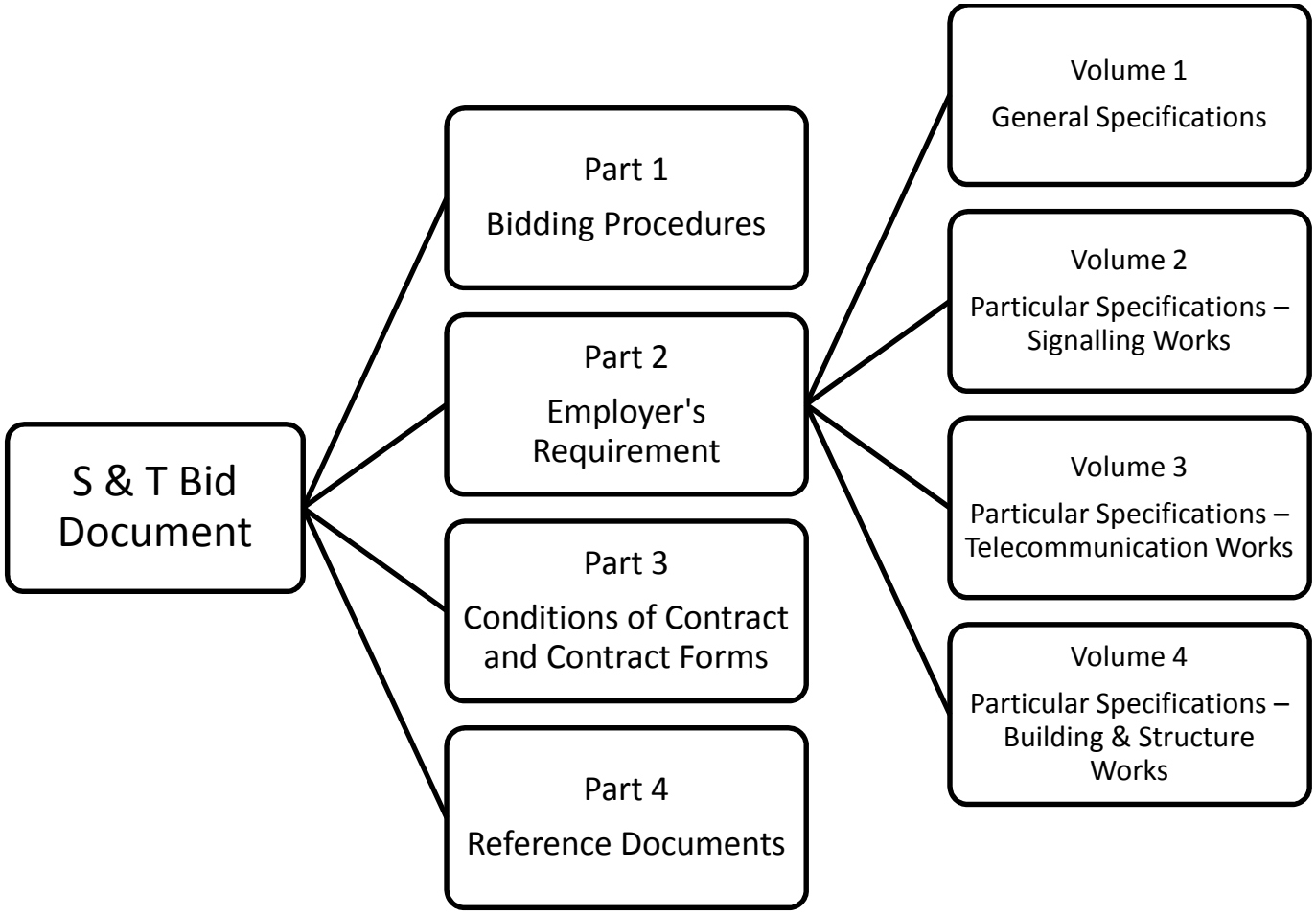
Issued on: **30-03-2015**

ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

Part 2, Section VI, Volume 2,
Particular Specifications
Signalling Works

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)

COUNTRY: **INDIA**


S & T Bid Document
Part 1
Bidding Procedures
Part 2
Employer's Requirement
Part 3
Conditions of Contract and Contract Forms
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General Specifications
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CHAPTER 1: INTRODUCTION

1.1 Introduction

1.1.1. Eastern Dedicated Freight Corridor (EDFC) Railway project will run from Ludhiana to Dankuni. Phase 2 of the EDFC project involves construction of the stretch from Mughalsarai to New Bhaupur. The details of the section are given in Para 1.2.1 of General Specifications, Vol.1 Part 2 Section VI.

1.1.2. The Mughalsarai- New Bhaupur section (EDFC Phase 2) will be double line railway track with 12 stations, of which 7 stations will be Crossing stations and 5 will be Junction stations. Details of Crossing and Junction stations are given in Para 1.2.3 of General specification Vol.1 Part 2 Section VI.

1.1.3. There are 75 level crossing gates in EDFC Phase-2, which will be replaced by ROB/RUB in a phased manner. It is anticipated that on 18 LC Gates, the work of ROB/RUB is not likely to be completed before the commissioning of Freight Corridor in the Section. Therefore these 18 LC Gates will be required to be interlocked with Gate Signals. The details of these Level Crossings are given in Annexure-1 of General specification Vol.1 Part 2 Section VI.

1.1.4. To provide integrated maintenance facilities for all functions – Civil, Electrical, S&T at a centralized location, Integrated Maintenance depots (IMD) – 3 Nos. and Integrated Maintenance Sub Depots (IMSD) – 5 Nos. have been planned to be constructed. The details of maintenance depots are covered in Para 1.2.5 of General specification Vol.1 Part 2 Section VI.

1.1.5. The EDFC Centralized Operational Control Centre, being provided at Allahabad under CP 104, will be used to house the Train Management system (TMS) and Traction Power SCADA system of EDFC Phase 2. The details of OCC are covered in Para 1.2.7 of General specification Vol.1 Part 2 Section VI.

1.1.6. The Civil Structures and Track works in Mughalsarai- New Bhaupur section are being/have started. The present work is for construction of Signalling and Telecommunication system on Mughalsarai- New Bhaupur section of EDFC. This specification details the technical requirements for the Signalling system to be implemented on this section.

1.1.7. The Contractor shall consider the Project Objectives and scope of works contained in this chapter and then using the requirements given in this document develop an appropriate Signalling system that meets the System requirements for design, implementation and support.

1.2 Objective

1.2.1 The objective is to design, build, install and test a safe and reliable Signalling system for the Mughalsarai- New Bhaupur section of EDFC.

1.2.2 The project section is divided into number of stations. Each station will be responsible for the operation of the section in its control area. The control in each station is to be accomplished by a local control system and will be staffed by Station Masters.

1.2.3 Safety is of primary concern. The aim is to minimize accidents and incidents during the implementation phase of the project, as well as to reduce operational accidents and incidents when the new Signalling system is brought into use.

1.2.4 It is an objective to install a system that will be designed to have a prolonged life cycle. As such, any of its sub-system installed should be capable of mid-life upgrade with minimal disruption to traffic operations. The Equipment is expected to remain operational during wide environmental conditions found along the proposed route.

1.2.5 The maintenance cost of the system should be kept to the minimum. The Signalling system should therefore be designed to require minimal maintenance and a suitable maintenance strategy shall be agreed with the Employer. The strategy shall incorporate the use of diagnostic data acquisition and storage to support the system maintenance authority.

1.2.6 It is an objective to install all equipment in the minimum time available commensurate with the project aims. To achieve this, the Signalling system is to be designed on a modular basis such that a generic design exists at all stations as far as possible, with variations to meet the local requirements. The contractor is encouraged to design the Signalling system in such a way that it can be pre-fabricated and tested at a central place away from the site and then delivered to site and installed. Commissioning and bringing into service of the Signalling will then be achieved on a station by station basis as defined in this document.

1.2.7 It is an objective of this contract to ensure that the environmental impact associated with the Signalling works is minimized.

1.2.8 It is an objective of this contract to minimize the energy cost. The Signalling system shall be designed for minimum energy consumption.

1.2.9 It is an objective of this contract to encourage innovation and innovative solutions that allow for a rapid implementation of the Signalling system. The contractors are encouraged to offer innovative, modular solutions to meet the system requirements.

1.3 Signalling Overview

1.3.1 The entire stretch from Mughalsarai to New Bhaupur will be provided with Automatic Block Signalling (ABS). Trains will run observing automatic/ semi-automatic signals en route which in normal conditions will be set for a through and uninterrupted run.

1.3.2 The lines connecting DFCCIL Junction stations to IR stations shall be provided with Absolute Block/Slot working.

1.3.3 The Signals, Points, LC gates, Track-vacancy detection systems and other Signalling equipment at the stations and in the block sections will be controlled/monitored by Electronic Interlocking (EI) located at Stations and at Auto Location Huts along the route. The Electronic Interlocking architecture including their size, numbers, locations and bandwidth requirement for the system shall be determined by the contractor's design. The OFC required for communication between the EI shall be provided under PS (Telecommunications) Vol. 3 Part 2.

1.3.4 It is a requirement that Digital Axle counter technology is used to provide primary track vacancy detection function at the Stations and the Block sections. The Track vacancy detection system architecture including size, numbers and locations shall be determined by the contractor's design. The OFC, if used for communication between the Evaluator and the track devices shall be provided under PS (Telecommunications) Vol. 3 Part 2.

1.3.5 The Power supply for the Signalling System shall be provided using Integrated Power Supply (IPS)/Uninterrupted Power Supply (UPS). The Power supply scheme including rating, quantity and locations of Power supply systems, shall be determined by the contractor's design.

1.3.6 The Train Management System (TMS) shall be housed in OCC at Allahabad. The TMS will collect real time data of important Signalling functions of stations and of block sections and display it in the OCC. For this purpose, the OFC required for communication shall be provided under PS (Telecommunications) Vol. 3 Part 2. The Traffic Controllers at the OCC shall be provided with an overview of the movement of trains on a Video Wall, sufficient to supervise and monitor train movements across the whole section and will control train operations by voice command using the Telecommunication System.

1.3.7 While the Traffic controllers at OCC will manage overall train operations, the operations at local level will be managed by Station Masters located at the stations along the route. Station Masters will require an appropriate display and sufficient control to support their activity under both normal and abnormal railway operations. The Station Masters will receive train service and management information from the Traffic Controller located at the OCC.

1.3.8 The 'Traction Power SCADA Control system' is being provided under Contract Package (CP 204). The Video wall for display of SCADA system as well as the SCADA Channels shall, however be provided by the Signalling system under this specification.

1.3.9 An Overview of Signalling system architecture and its Interface is placed at Appendix 7.

1.3.10 The Signal Maintenance bases will be located in IMD and IMSD. The buildings for IMD and IMSD are being provided under Contract Package CP 201 & 202.

1.3.11 The 230V power supply for the Signalling system will be provided by the contractor for the Electrification works under Contract Package 204. The Bidders are requested to determine their 230V power supply requirements in accordance with Para 2.2.9 of this specification.

1.3.12 The Signalling system shall be housed in Signal Equipment Rooms (SER). While SER at Stations will be constructed as part of Station building under Contract Package 201 & 202, the Auto Location Huts (ALH) for housing Signalling and Telecommunication equipment in the Block sections shall be provided by the Contractor under PS Buildings & Structures, Vol. 4, Part 2, Section VI. The number, size and location of ALH shall be determined by the contractor's design.

1.3.13 Communication of control signals for both Signalling and Telecommunications shall be distributed via an Optical Fibre Data Transmission network

1.4 Scope of Works

1.4.1 The Signalling system scope is comprised of the following:

(1) Design and implementation of the Signalling works including Electronic interlocking and power supply arrangements at seven (7) Crossing stations viz. New Dagmagpur, New Mirjapur, New Unchdih, New Manauri, New Sujatpur, New Rasulabad and New Malwan and five (5) Junction stations at Mughalsarai, New Ahraura Road, New Karchana, New Kanpur and New Bhimsen.

(2) Design and Implementation of Absolute Block/Slot working on single lines connecting DFCCIL and IR stations viz. New Bhimsen to Bhimsen (IR), New Karchana to Iradatganj (IR), New Karchana to Cheoki (IR), New Ahraura road to Jeonathpur (IR) and New Kanpur to Rooma (IR) and lines connecting Mughalsarai (EDFC) and Mughalsarai (IR) stations.

(3) Design and Implementation of Automatic Signalling in a continuous stretch on DFCCIL Main lines from Mughalsarai to New Bhaupur. This shall include facility for

introduction of modified automatic working during abnormal conditions such as Fog, bad weather impairing visibility etc. This is to be accomplished by modifying a mid-section automatic signal of each block section into semi-automatic stop signal, which will be interlocked with Home Signal of station ahead and Advance Starter of station in rear in both directions, in accordance with General rules of Indian Railways.

(4) Design and Implementation of the Interlocking of 18 LC gates on proposed main line and link lines between DFCC Junction stations and IR stations. This shall include design and implementation of gateman's emergency control system and appropriate display system and power supply system. List of LC gates is placed at Annexure 1 of General Specification Vol. 1 part 2 section VI.

(5) Design and Implementation of a Train Management System (TMS) for supervision, management and monitoring of train traffic on the Mughalsarai- New Bhaupur section. This shall include the provision of Video Wall Display for Signalling and SCADA system of Mughalsarai- New Bhaupur section.

(6) Design and implementation of Service & Diagnostic (S&D) system for monitoring and supervision of health of Signalling equipment and its power supply.

(7) "Design and Implementation" means all activities associated with designing a Signalling system to meet the Employer's requirements, manufacture & supply, storage, Installation/Construction, testing and commissioning, training, supply of spares and documentation, removal of temporary works, handover of the system to the Employer and support during Defect Notification period and beyond as per provisions of Employers Requirements.

(8) All associated works required for satisfactory completion of works as defined in this Particular specifications.

1.5 Relevant Documents

1.5.1 This Particular Specification (PS) shall be read in conjunction with the Conditions of Contract, the General Specification (GS), and any other document forming part of the Contract.

1.5.2 In the event of a conflict between the GS and PS (Signalling), the requirements of PS (Signalling) shall prevail.

1.5.3 In the event of a conflict between this document and others, the following precedence shall apply:

(1) Employer's Requirements - Particular Specification (Signalling)
(2) Employer's Requirements - General Specification.
(3) Indian Standards referenced herein.
(4) International Standards referenced herein.
(5) Other International Standards.
(6) Other National Standards.

1.5.4 Notwithstanding the precedence specified above, the Contractor shall seek clarification from the Engineer in the event of conflict among above specifications and decision of the Engineer shall be final and binding.

(End of Chapter 1)

CHAPTER 2: SYSTEM REQUIREMENTS

2.1 Introduction

2.1.1 A new Signalling system is required for the Mughalsarai- New Bhaupur railway line. The main components of the system shall be Electronic Interlocking, Track vacancy detection using DAC, LC gate Interlocking, Line Side Signals, Point Machines, Service and diagnostic system and Train Management System

2.1.2 The design life of Signalling sub system/equipment (except maintenance free batteries and cables) shall be a minimum of 15 years. The design life of Signalling cables shall be at least 25 years.

2.1.3 For reasons of operational availability, a distributed control capability is required with an interlocking used within each station area of control to ensure points, LC gates and signals do not conflict and that the train is protected from point movement and LC gate opening during its passage.

2.1.4 It is anticipated that Centralized Traffic Control (CTC) and Train Protection Warning System (TPWS) may be required in the future, therefore system provided under this contract shall be designed as demonstrable to be “future proofed” for the same.

2.1.5 The System shall be designed in such a manner that the failure of a single item of equipment shall not cause loss of overall system functionality. The use of redundancy, hot standby and cold standby shall be considered in accordance with meeting the system objectives.

2.1.6 The System shall remain fully functional with no degradation across the range of published climatic conditions found in the region. The Climatic conditions are covered under Para 2.5 of GS Vol. 1 Part 2 Section VI.

2.1.7 The System shall be designed to be repaired without loss of overall functionality.

2.1.8 The System shall be designed to operate correctly and safely within a 25 KV AT feeding system environment and shall present no hazards to personnel.

2.1.9 The System design shall be modular and amenable to assembly and testing away from the final installation site.

2.1.10 The System shall be designed keeping energy usage as a key feature of design philosophy and making it part of the review of the system design.

2.1.11 The System shall be designed and installed in such a manner that theft and vandalism are discouraged. Line side units shall feature locks and similar deterrent features preventing plug coupled cables and modules from being removed, and larger structures shall feature anti vandalism measures to the satisfaction of the Engineer.

2.1.12 The System shall be designed to incorporate a Service and Diagnostic system to be used to support railway maintenance activities.

2.1.13 The System shall be designed to interface with Signalling systems on adjacent sections of EDFC and Signalling systems of linked IR stations.

2.2 Signalling System Requirements

2.2.1 General

(1) Automatic Signalling shall be provided on Main lines in a continuous stretch from Mughalsarai to New Bhaupur with 4 Aspect Colour Light Signals (MACLS) at a nominal spacing of 2 Km.

(2) Facility shall also be provided for introduction of modified automatic working during abnormal conditions such as Fog, bad weather impairing visibility etc. This is to be achieved by modifying a mid-section automatic signal in each direction and in each block section into modified semi-automatic stop signal and suitably interlocking it with Home Signal of station ahead and Advance Starter of station in rear in accordance with Indian Railway (Open line) General rules 1976 sub rule (1) clause (ba) of rule 3.12 & sub rule (3) of rule 9.01.

(3) Absolute block working on single line connections between DFCCIL and IR stations shall be provided using Solid State Block proving by Axle Counter as per RDSO spec. RDSO/SPN/175/2005 or Block proving by Axle Counter using UFSBI as per RDSO spec. IRS: S105/2012. Wherever provision of Absolute Block working as described above is not feasible provision of Slot working with all necessary safety features and counters be considered.

(4) Station area shall be designed for maximum flexibility and shall be fully signalled in accordance with current IR practices.

(5) Interlocking of Stations and Block sections shall be provided using Electronic Interlocking.

(6) Track Vacancy Detection System shall primarily use Digital Axle Counters (DAC).

2.2.2 Signals

(1) **System Requirements**

(a) All Signals and Subsidiary signals should be designed and implemented in accordance with Indian railways General rules and Signal engineering Manual and other requirements of this specification.

(b) The design of the proposed Automatic Block Signalling system shall, as far as possible avoid positioning of signals at following locations, where they can display a red 'STOP' aspect:

(i) Where trains may stop inside a tunnel;
(ii) Where trains may stop on top of a viaduct;
(iii) Where trains may stop across a junction or a point of conflict with another train;
(iv) Where trains may stop over a level crossing;
(v) Where trains may stop inside or too close to an OHE Neutral Section;
(vi) Where trains may stop at steep up/down gradient
(vii) Where trains may stop in a position that is considered dangerous.

(c) All Main line signals shall be 4 aspect Colour light automatic/semi-automatic line side signals. The signals on the loop lines shall be 2 aspect Manual signals.

(d) All the automatic/ semi-automatic signals shall be fitted with A marker disc, G marker disc, illuminated 'A' marker and illuminated 'AG' marker in accordance with provisions of IR General Rules and Signal Engineering Manual.

(e) A CSL board shall be provided on the Starter signals indicating Clear Standing Length of the line.

(f) Position light type Shunt signals shall be provided below all Starter and

Intermediate Starter signals.

(g) Independent Position light type Shunt signals shall be provided for exit from sidings and shunt back from Advanced Starter. Sufficient number of such Shunt signals shall be provided so as to allow maximum flexibility in shunting movements in the yard.

(h) Calling-ON signal shall be provided below Home signals and Intermediate Starter signals on extended loops of Junction stations.

(i) The Signals leading to more than one route shall be provided with Junction type Route indicators.

(j) All the Signals - Main and Auxiliary, shall be equipped with LED signal lighting units.

(2) **Technical requirements**

The Colour light tubular signal posts, outside dia. 140mm, length 3.6/4.6/5.6 meters (as per requirement) complete with surface base, anchor bolts, ladder with platform guard rail etc. shall be provided as per spec No. IRS-S-6/81 and relevant RDSO drawings.

(a) The Main running signals shall be Multi unit Colour Light Signals as per RDSO spec. No. IRS: S26-64 and relevant RDSO drawings.

(b) All signals, main or subsidiary shall use Light Emitting Diode Signal lighting unit as per RDSO specification No. RDSO/SPN/153/2011. LED Signal lighting unit shall work on 110V 50 Hz AC. ECRs as per RDSO specification STS/E/Relays/AC Lit LED Signal/09-2002 shall only be used with LED signal lighting units.

(c) Directions type (Junction Type) route Indicators (5 lamp unit arm) using LED signal light, complete with all the fittings shall be supplied as per IRS: S-66/1985 and relevant RDSO drawings.

(d) Installation of Signals

(i) Signals shall be installed clear of the structure gauge as per the provisions of IRSEM and SOD of EDFC.

(ii) The signal shall be so located that a clear view is available to the driver of an approaching train and is as close to the track as permissible. The actual visibility of signal shall be checked by a sighting committee and action to improve the visibility as per recommendation of the committee shall be taken before commissioning any new signal. The Signal sighting committee shall be nominated by the Engineer.

(iii) Location of signals shall be worked out as per the requirement of chapter XXII of IRSEM (Special Requirement of Signalling in 25 KV AC electrified area), 2x 25 KV AC AT feed system of DFC, 25 KV AC traction system of nearby IR and DFC Schedule of dimensions for Eastern Corridor. The signal shall be located beyond electrical clearances. Suitable iron screening shall be provided if electrical clearances are not achieved.

(iv) All mountings on signal post viz. Shunt signal, ‘Calling ON’ signals, ‘A’ and ‘AG’ marker lights of Semi-Automatic signals shall be done using

separate brackets of suitable size for each of them.

(v) Signals on posts shall be equipped with a ladder enabling access to the LED Signal lighting units as well as Shunt signal, Calling 'ON' signal and 'A' marker, 'AG' marker lights mounted on the post.

(vi) Emergency sockets shall be installed on the Signal posts under PS (Telecommunications) Vol. 3 Part 2.

(vii) In case Signal units are required to be mounted on gantry, the contractor shall submit a suitable gantry design clear of SOD of DFCC Eastern Corridor & electrical clearances and amenable to maintenance for the approval of the engineer. Working instructions for maintenance of gantry mounted signals shall be suitably incorporated in the maintenance plan. Special tools, test equipment including access ladders and protective gear needed for maintenance of these gantry mounted signals shall also be supplied.

(viii) Suitable Earthing arrangements shall be provided for all signals.

(3) **Foundations for Signals**

(a) The foundations of signals must be made of concrete.

(b) The foundations must be dimensioned sufficiently for signals on posts, gantry and shunt signals.

(c) The height of the foundations must be adjusted to the geographical situation (slope, etc.) and to the location of the signals.

(d) The height of independent Position Light Shunt signal shall not exceed a maximum limit that may infringe the SOD of IR and Eastern Corridor of DFCC.

(e) The foundation drawings of Main signal and Position Light Shunt Signals (Independent) shall be proposed by the Contractor and approved by the Engineer.

(f) Suitable pre-fabricated assembly units of reinforced concrete may be used with the approval of the Engineer. In this case, the foundation must have one or several eyebolts for transport purposes. They must be closed after final mounting.

2.2.3 Interlocking

(1) **General**

The principles of interlocking as per IRSEM shall be followed while designing the Signalling system.

(2) **System requirements**

(a) Each Station control area including adjacent block sections shall have a high integrity electronic interlocking suited to work with a Control terminal for Signalling control.

(b) The Electronic Interlocking shall be housed in Signal Equipment Rooms (SER) at the stations and in the block section. The number of Electronic Interlocking and their locations shall be determined by the Contractor's design.

(c) Wherever interlocking equipment (Central Interlocking Unit or Object Controller) is located, a display shall be available showing the state of the railway under control by that interlocking and up to the neighboring control area on both sides. The display shall be provided in all the Signalling Equipment Rooms at Stations and in Block section Auto location Huts where Interlocking Equipment (Central Interlocking Unit or Object Controller) is located. While the display at all interlocking Equipment (Central Interlocking Unit or Object Controller) will cover only area under control of that interlocking, the display at Station interlocking shall cover area up to the next (adjacent) stations on both sides.

(d) The interlocking shall be provided with a data recording system allowing all interlocking states to be time stamped and recorded. The data recording system shall record and retain interlocking state data for a minimum period of 7 days on a rolling 7 day basis. Interlocking data shall be available to the user for interrogation through a suitable PC interface.

(3) **Technical requirements**

(a) The Electronic Interlocking (EI) shall be as per RDSO specification RDSO/SPN/192/2005 or RDSO/SPN/203/2011 and procured as per Para 4.2 of this specification. .

(b) Separate I/O Cards shall be used for UP & DN lines for improved functionality.

(c) It shall be capable of interfacing with TMS and TPWS systems using serial/ Ethernet/OFC ports.

(d) The System design shall ensure that required integrity of safety related vital information is maintained during communication between EI and EI/Object Controllers and between EI and TMS at OCC. In this regard, the requirements for transmission of vital safety information, as laid down in RDSO/SPN/144/2006 and EN 50159 shall be followed.

(e) The EI Processor shall have sufficient capacity to handle, without any degradation, the load of additional I/O when added in future utilizing available spare provisions as indicated at Para 2.2.3(4)(f).

(f) Interlocking input and output circuits and associated interface cabling shall be suitable for use within 2x25 KV AT system environment and shall be suitably protected against transient and high voltage discharge interference.

(g) All the Electronic Interlocking shall be connected through duplicated self-healing fail safe OFC rings for transfer of vital data among EI systems. The connection shall be such that full network protection against single fibre failure is available with seamless switchover between the redundant OFC's. The contractor shall make maximum use of shared backbone communication links for diagnostic and operational information transfer.

(4) **Interlocking Design**

(a) The Alignment Plans and Yard plans have been provided under Part 4 – Reference documents. These shall be reviewed and revalidated by the contractor from Signalling & Interlocking point of view.

(b) Based on the approved Yard plans, the contractor shall prepare the Signal Interlocking plans (SIP) and the Control Tables for the Stations and Block

sections. The SIP and Control Tables shall be prepared in accordance with interlocking principles provided for in the IRSEM.

(c) The approved SIP and the Tables of Control shall form the basis for the design of Signalling system.

(d) The interlocking shall be designed with a hot standby capability.

(e) EI system shall ensure the compliance of provisions of IRSEM, including the following:

(i) Route Locking after Route setting;
(ii) Route holding when train passes through the route set;
(iii) Approach locking after route cancellation when train approached the set route (including gate signals); and
(iv) On all legitimate routes, the conditions and the signal aspects shall be laid down in the Interlocking Table/chart.

(f) The System shall have provision for accommodating additional 20% of the I/O used as minimum spare provision, including corresponding Processor capacity for future use.

(5) **Mid-Section Semi-automatic Signal**

Mid-section modified semi-automatic signal in each direction and each block section (between two adjacent stations) shall be provided as per Indian railways General Rules referred at Para 2.2.1(2) above. The following system of working shall be implemented:

(i) the mid-section modified semi-automatic stop signal so provided shall be interlocked with the signals of the station ahead through axle counters and shall be controlled by the Station Master of the station ahead, the relevant indications whether the signal is in normal automatic mode or modified semi-automatic mode shall be available to the Station Masters at both the ends;

(ii) Advanced starter signal of the station in rear shall be interlocked with the mid-section modified semi-automatic stop signal in such a way that when working with 'A sign extinguished, the Advanced starter shall assume 'off' aspect or be taken 'off' only when the line is clear upto an adequate distance beyond the mid-section modified semi-automatic stop signal; similarly the mid-section modified semi-automatic stop signal shall assume 'off' aspect automatically or be taken 'off' only when the line is clear upto an adequate distance beyond the Home signal of the station ahead;

(iii) During abnormal conditions like fog, bad weather impairing visibility, the mid-section modified semi-automatic stop signal may be worked by extinguishing 'A' maker in the manner prescribed under special instructions and this action shall also ensure that the 'A' marker of the Advanced starter signal of the station in rear and Home signal of the station in advance shall also be extinguished;

(iv) During normal conditions, mid-section modified semi-automatic stop signal shall work as normal automatic stop signal;

(v) When the Loco Pilot finds mid-section modified semi- automatic stop signal with 'A' marker extinguished in 'on' position, he shall stop his train in the rear of the signal and inform this fact to the Station Master of the station

ahead on approved means of communication as prescribed under special instructions; and

(vi) The Station Master of the station ahead may authorise the Loco Pilot to pass the mid-section modified semi-automatic stop signal working with 'A' marker extinguished in 'on' position through approved means of communication after ensuring conditions and procedure prescribed under special instruction.

2.2.4 Control system

(1) **System requirements**

(a) For reasons of operational availability, a distributed control capability is required on the section.

(b) There shall be a Control terminal in Hot Standby mode provided at every Station with the Station Master. There shall be no Control terminal in the block section. The Control terminal provided with the Station Master at the Station shall be used to control the Station yard and block section (part or complete), under control of the said Station Master. The display on the Control terminal shall however, include not only the current state of railway under control of the Station Master, but shall also include further display for the complete block sections up to the adjacent stations on both sides.

(c) The Control terminal shall have hard SM key/ smart card or login facility to authenticate the operator for operation and transfer from one Control terminal to another.

(d) Diagnostic functions shall not be operative from the Control Terminal.

(e) Signalling control shall be available on only one Control Terminal (Main or Standby) at a time, to avoid conflicting control commands.

(f) Route Locking, route holding and all locking of signals as well as points and crossings shall not be affected if there is a transfer of control from one Control terminal to another.

(g) The SM shall have facility to put back any signal (including automatic signals) under his control to ON position.

(h) Certain operations are regarded as safety critical and shall require two stage commands, such as, latched key, simultaneous operation with more than two (02) switches or buttons, or co-operated operation by two persons. Following are some examples of safety critical operations:

(i) Route Cancellation.

(ii) Point machine Crank handle release.

(iii) Point operation under Track section failure.

(iv) Resetting of Axle Counter.

(i) The contractor shall prepare and submit list of such safety critical operations derived from an analysis of the system, along with the proposed two stage command protocol for the Engineer's review and acceptance.

(2) **Technical requirements**

(a) The Control terminal shall be provided with full redundancy (1+1) in hot standby mode. When changeover takes place, it should be ensured that requirement of 2.2.4(1)(e) & (f) continue to be met.

(b) The Control terminal shall have a latest industrial grade embedded fan less PC with no external drive, colour VDU monitor with minimum size of 32".

(c) The Software of Control terminal shall be validated to SIL-2. All safety critical functions shall be compliant to SIL4.

(d) The Control terminal shall be connected to EI on duplicate cables, preferably OFC laid through diverse routes.

(e) The Control terminal shall work on 230V ± 10%, 50 Hz AC power supply. It shall be provided with power back up of 4 hours either through UPS/IPS of the Station Signalling system or by providing a separate UPS system.

2.2.5 Track Vacancy Detection System

(1) **System requirements**

(a) Track-vacancy detection shall be continuous, provided in the Block sections and at the Stations, on all the lines, including berthing portions of sidings at the stations.

(b) The track vacancy detection technique shall use Digital Axle Counter technology as a primary means of train detection. Where required, a secondary means of track vacancy detection can be used to supplement the primary means with the approval of the Engineer.

(c) The presence of trains and vehicles shall be positively detected, under all modes of system operation. However, Light vehicles like push trolley, dip lorry and the rail dolly etc. which are being used on Indian Railways, shall not affect the functioning of the DAC.

(d) The tolerance of detection accuracy for detecting the position of the vehicle/ train shall be such that safety is maintained, operational requirements are fulfilled and fouling marks are not infringed, under worst-case conditions.

(e) The location of the Evaluator, vital relays & other MSDAC equipment and their cabling & power supply requirement shall be determined by contractor's choice of equipment and design.

(f) The contractor should comprehensively detail the impact of system failure on train detection and the impact on train detection once the failure is restored.

(g) At the boundary with adjacent section of EDFC, the track vacancy detection system provided shall achieve no loss of continuous detection at any point of time.

(2) **Technical requirements**

(a) The Track-vacancy detection system shall be designed to meet the requirements of SIL 4 as defined in IEC 61508.

(b) Track-vacancy detection at the stations and in the block sections shall be Multi Section Digital Axle Counters (MSDAC) as per RDSO specification no. RDSO/SPN/176/2005 and procured as per Para 4.2 of this specification.

(c) Single Section Digital Axle Counter (SSDAC) as per RDSO specification no. RDSO/SPN/177/2005 and procured as per Para 4.2 of this specification

shall be provided on single lines connecting DFCCIL and IR Junction stations that are provided with Absolute block working.

(d) The detection system shall be suitable for use with UIC 60 Kg. rail.

(e) When the Signalling system starts after long duration power failure, all track sections shall show occupied until reset by the Station master(s).

(f) Track devices on crossovers /points shall be provided considering Flank Protection.

(g) The track-vacancy detection system in the Block section shall have Main system and Supervisory system. The Main and Supervisory systems shall be provided on different rails. The Supervisory system shall have a track section for every two Main system track sections. The purpose of providing the Supervisory system is to enable smooth operation by avoiding manual resetting during failure of a track section. In case the track section(s) of the Main system fail(s) with its corresponding track section of the Supervisory system showing clear or vice versa, it will automatically reset the failed track section(s). A typical scheme for Track vacancy detection system using MSDAC in Automatic Block Section is placed at Appendix 5.

(h) The track-vacancy detection system at the Stations shall have only Main system with no Supervisory system.

(i) Detection Points and Track sections

(i) In order to minimize the number of track sections in Automatic Block Section, no separate track section shall be provided for overlap portion. A single track section shall include the route as well as the overlap of the signal. Thus, one track section will overlap the adjacent track section in the signal overlap portion. This shall be applicable for Main system as well as Supervisory system, where used.

(ii) The Supervisory system, where used shall be provided on different rails from the Main system and shall not have any common DP with the Main system. Each supervisory track section shall cover not more than two track sections.

(iii) The first DP of a track section in Automatic Block Section shall be located at least at 13 metre from the foot of the signal controlled by the track section. The other DP of this track section shall be at not less than the overlap distance from the next signal in the direction of train movement.

(iv) At the boundary with adjacent section of EDFC, the DP of the last track section shall be so located that the track section overlaps with the track section of the track vacancy detection system of the adjacent section. The distance between the two adjacent DPs shall be sufficient not to cause any interference between the two systems.

(v) The detection points attached to the rail must be protected by means of deflectors against mechanical damage that can be caused by parts of running trains.

(j) Evaluators

(i) Separate Evaluators shall be provided for UP and DOWN lines.

(ii) The Supervisory system, where used, shall have a separate Evaluator from the Main system.

(iii) However, if Evaluator of UP line Main system have spare capacity (keeping 20% of equipment used capacity reserved for further use), then it can be used for providing Supervisory system of DN line, and vice versa.

(iv) A standby Evaluator with complete programming and configuration shall be provided for every Evaluator at Stations and Block Sections with arrangement for switch over using a single switch. After every change over, the track sections shall go in error state and shall have to be reset as per manual resetting procedure.

(k) Communication

(i) The transmission between Central Evaluator and Field units of UP and DN systems shall be in separate cables, preferably of different kinds, say OFC and quad.

(ii) The transmission between Central Evaluator and Field units of Main and Supervisory systems shall be in separate cables, preferably of different kinds, say OFC and quad.

(iii) Wherever feasible, the Supervisory system of UP line can be provided on cable for Main system of DN line and Supervisory system of DN line can be provided on cable for Main system of UP line.

(l) Resetting Arrangement

(i) Manual Resetting

(a) A suitable resetting scheme shall be designed by the contractor for manual resetting of axle counter track sections at stations and block sections. This shall be achieved through a mix of system design and the operating procedures. The scheme should avoid, to the extent possible physical verification of track at site, without affecting safety.

(b) The scheme, as far as possible, shall make use of Station Master's Control terminal for resetting operations.

(c) Provision shall be made to record every operation of resetting by non-resettable counter. The counter shall count, every time the resetting is done and shall not reset back on failure of control terminal /power supply.

(d) Preparatory reset of a track section shall not disturb other track sections in any way.

(ii) Automatic Resetting in Automatic Block section

When any track section of the Main system fails with its Supervisory track section showing clear, then the failed track section should get automatcially reset. Similarly, when the Supervisory track section fails with both track sections of the Main system supervised by it showing clear, then the failed Supervisory track section will get automatically reset. This shall considerably reduce the occasions for resorting to manual resetting & will help smooth train operation.

(3) **Installation and Entry into Service**

(a) The trackside equipment shall be installed on that side of the track, which is less dangerous for maintenance staff. It should not be installed between the main line tracks.

(b) The requirement of track maintenance machines (mechanized) shall be taken into account while installing outdoor equipment. Trackside Equipment installations shall be agreed with the Engineer prior to installation to avoid conflict with track maintenance machines.

(c) Where feasible, the trackside equipment shall be housed in sturdy lockable location boxes as an anti-theft measure. Additional anti-theft measures shall be proposed by the Contractor and approved by the Engineer at the time of installation.

2.2.6 Railway Crossings

(1) **System requirements**

(a) All the level crossing gates falling on DFCCIL shall be interlocked with signals.

(b) There are 75 level crossing gates in Mughalsarai- New Bhaupur section, which are being replaced by ROB/RUB in a phased manner. It is anticipated that ROB/RUB work on 18 LC gates is not likely to be completed before the commissioning of the section. Therefore, these 18 LC gates will be required to be interlocked. The details of these level crossings are available at Annexure 1 of GS, Vol.1 Part 2 Section VI.

(c) For the 18 LC gates to be interlocked, Gate Huts are being constructed under Contract Packages 201 & 202. The IR gateman will operate the LC gates from the new gate lodges as per 'Working methodology for LC gates' at Appendix 1.

(d) At present these 18 LC gates are interlocked with IR gate signals. These would be replaced with an arrangement where they cover both IR and new DFCCIL tracks and are interlocked with both IR and new gate signals on DFCCIL lines.

(e) Single set of electrically operated common lifting barriers shall be provided outside the Indian Railways and DFCCIL tracks so as to protect both the railway as well as DFCCIL tracks by one set of lifting barriers. In case the distance between IR and DFCCIL tracks is such that a single set of barriers is considered unsafe or operationally unmanageable, the decision on providing two separate set of barriers under exceptional cases can be taken by the Engineer on the basis of local conditions.

(f) A separate panel for the operation of the booms shall be provided wherein the buttons be provided for raising/lowering the booms. Facility shall exist to stop the booms midway during operation, should a vehicle come under the boom or enter the level crossing gate during the process of closure.

(g) Colour light Road signals and audio warning shall be provided to warn the road users regarding the approach of a train.

(h) The gateman shall be provided with audio visual 'Train Approach Warning' indication from a distance of at least 8 Kms on DFFCIL lines. When the train reaches the approach warning track section in rear of the gate, a buzzer should start sounding in the gate-hut intimating the gateman of the

approach of a train. The gateman will close the gate and clear the gate signal provided the relevant track sections ahead are clear. When the lowering of the booms takes place, hooter shall sound to warn the road users of an approaching train. Also, the road signals shall start displaying a flashing red light towards the road users, which shall turn to steady red when the booms are fully lowered.

(i) Another warning buzzer shall also sound when the train reaches a distance of 4 Kms (approach locking track section) on DFCCIL lines. At this stage, if the gate is in closed position, track locking of the booms shall take place so that the booms cannot be opened thereafter till the passage of the train from the level-crossing. The route will get automatically released with the passage of train past the nominated track sections ahead of the gate signal. The gateman will then be free to open the gate.

(j) A common indication panel shall be provided in the new gate hut, where in indication for the 'ON' and 'OFF' aspects of gates signals (wherever provided) for both the systems (IR and DFCCIL) as also the occupation/ clearance of the controlling track circuits up to the point of approach warning shall be displayed. Direction of movement of the trains shall also be displayed on the panel. The changes in IR circuits, if required shall be carried out and commissioned by IR. The contractor will only be required to extend the IR gate signal aspects, approach track sections etc. to common indication panel through requisite interface.

(k) The gateman shall be provided with facility to put back the gate signals to ON in case of emergency.

(l) Arrangement for manual emergency operation of the boom shall also be provided which can be used when it is not possible to close or open the booms electrically due to some defect or otherwise.

(m) Telephone with selective ringing arrangement between gateman and Station Master as well as between the gateman of the adjacent gate is being provided under PS (Telecommunications), Vol. 3 Part 2 Section VI.

(n) Arrangement for fixing of Safety chain and hand operated Safety boom (Sliding boom) shall be provided for use in case of failure of lifting barriers. Indication for fixing of safety chain and hand operated boom shall also be provided on the panel of Station Master. An arrangement shall be provided for taking 'OFF' the relevant gate signal when the safety chain and hand operated boom is properly locked and detected by the system. In this case, the gate signal shall display 'YELLOW' aspect.

(2) **Technical Requirements**

(a) As all the Level Crossing gates are planned to be replaced by RUB/ROB in future, the system design for interlocking of these LC gates shall be such that it requires minimum changes to initial design for the same and the change is implemented in a cost effective and time efficient manner.

(b) The LC gates on DFCCIL shall be protected with semi-automatic Gate signals and provided with G marker disc, illuminated 'A' marker and Illuminated 'AG' marker, as per provisions of Indian railways General rules and Signal Engineering manual..

(c) New Electric Lifting Barrier (ELB) as per RDSO specification RDSO/SPN/208/2012 and procured as per Para 4.2 of this specification, shall be provided on the LC gates. Fringes shall not be provided on the ELB.

(d) The lifting barrier shall work on 110V AC 50Hz single phase supply. The 110V power supply shall be extended from the nearest Signalling Power supply system at the ALH/Station.

(e) Length of the boom shall be sufficient to cover the full width of the road. The ELB shall be installed as per the provisions of IRSEM and IRPWM.

(f) The Gate signals on DFCCIL lines will be interlocked with new ELB and DFCCIL line gate signal aspects and controlling track indications are provided on Domino Type Control cum Indication Panel (CCIP) in the new gate hut.

(g) The Common Indication Panel for IR and DFCC lines shall be a Domino Type Control cum Indication Panel (CCIP), provided as per RDSO specification RDSO/SPN/186/2004 and procured as per Para 4.2 of this specification.

(h) The Contractor shall carry out all work, including laying of cables between the new ELB and IR Control cum indication panel and DFCCIL CCIP and Operating panel, required for extension of interface/displays between DFCCIL and IR systems.

(i) Road signals, audio visual warning and other safety devices for road users shall be provided at Level Crossing gates as per IRSEM. Signals at the level crossing shall display aspects to road users, as specified below:

(i) Yellow, when gate is open to road users
(ii) Flashing Red when the gate barriers are in the process of being closed
(iii) Steady Red when gate closed for road users

In addition, Audio warning to road users when gates are in the process of being closed shall also be sounded.

2.2.7 Points and Points machine

(1) **System requirements**

(a) On the EDFC system, modern turnouts and derailing switches are programmed to be used. The turnouts will be on 60 Kg rail, with thick web switches and weldable CMS crossings suitable for 25 tonne axle load and Speed potential of 100 Kmph on Main lines.

(b) The points laid in the various yards of the DFCCIL by the CST contractor shall meet all the requirements set out in paragraph 12.40 of Chapter XII of the IR Signal Engineering Manual for which the contractor shall interface with the CST contractor.

(c) The indicative list of items for which the contractor shall be required to maintain Interface with the CST contractor of Contract Package 201 & 202, is given in Chapter 10 of GS Vol. 1 Part 2 Section VI.

(d) All the points shall be worked with Electric Point machines.

(e) It shall be possible to operate trains through all points and crossings in all directions of travel. Loss of electrical power shall not cause a change of physical point status and the points shall remain locked in the last operated position.

(f) The Point machines and the ground connections supplied by the Contractor shall be compatible with turnouts and derailing switches provided by the CST contractor. The contractor shall interface with the CST contractor for the same.

(g) Point machines supplied shall be simple in operation and shall require minimum maintenance. They shall be small compact units, readily accessible and interchangeable.

(2) **Technical requirements**

(a) Non trailable Electric Point machines shall be as per specification IRS S 24-2002 and procured as per Para 4.2 of this specification. The Point machines shall be provided with external Clamp locking arrangement.

(b) Provision shall be made for individual manual operation of each point. Electrical Power shall get disconnected from the point drive under manual (crank handle) operation. Crank handles used for manual operation of point shall be interlocked such that removal of crank handle shall prevent setting of relevant routes. The number of crank handles shall be minimized by suitable grouping such that the impact on operations is minimal when the key is taken out.

(c) Point detection shall be provided to detect that each switch is positioned with sufficient accuracy to ensure safe travel through the point before authorizing a train movement over the point. The limits of Obstruction Test shall be as per the requirement of IRSEM.

(d) Where the points form a crossover, independent detection shall be provided for the points at each end of the crossover. The two independent detections can however, be proved together and read into EI as a single input.

(e) The relative position between the point machine and the stock rail shall be fixed such that independent movement is prevented.

(f) The super imposed detection is not permitted.

(g) Locking detection shall be provided to detect that the point lock is in the respective locked position before authorizing a train movement over the point.

(h) Provision shall be made for emergency operation of points during track section failure. Each such operation shall be recorded by a suitable counter.

(i) All point operating equipment and point operation & detection circuits shall be totally immune from traction current effects or other EMI sources.

(j) Point machine wires shall be protected to prevent short-circuiting and monitored continuously for earth leakage.

(3) **Point machine Installation**

(a) Point machines installed shall present a minimum hazard to people walking along the track.

(b) Point machines shall be installed beside the close switch leading to high speed movement clear of all infringements.

(c) No point machines shall be installed in between the main line tracks.

(d) The point machine cover shall be provided with secured locking mechanism.

(e) The point machine shall be installed as per RDSO/OEM checklist.

2.2.8 Relays

(1) The various types of relays used in interlocking systems shall comply with IRS specification no. S34 and the requirements of IRS, BS or BRS specifications or any other specifications as approved by the Engineer.

(2) Time element relays electronic type conforming to IRS/BS/BRS or of the specification approved by the Engineer shall be used. When electronic time element relays are used these shall be two in number and their contacts should be in series with each other.

(3) The relays shall be preferably of the plug-in type. The contractor shall seek the advice of the Engineer in case other than plug-in-type relays are proposed to be used.

(4) All plug-in Relays and relay groups shall be fitted with non-interchangeable interlocking device to prevent the wrong relays/relay group being accidentally plugged in during replacements.

(5) Removal or replacement of plug-in relays/relay groups during operation shall not cause any unsafe conditions in the circuits.

(6) All relays shall, to the extent possible be housed in the Signalling Equipment room.

(7) All relays shall have minimum 10% of working contacts as spare subject to a minimum of one front and one back contact.

(8) The use of relays within the signalling sub system shall, however be minimised by design.

2.2.9 Power Supply

(1) The power supply scheme for Signalling and Telecommunication System should be based on 230V 50Hz AC supply.

(2) This 230 V power supply will be provided by contractor of Contract Package 204 at all places except OCC. The 230V power supply at OCC will be provided by the contractor of Contract Package 104.

(3) At OCC, the contractor of CP 104 will provide a LT panel in which he will make available the 230V power supply for the Signalling and Telecommunication system. The Contractor shall coordinate with the contractor of CP 104 to draw the required power supply for S&T system.

(4) At other than OCC, the contractor of CP 204 will provide the Auto Change over Switch (ACO) near/inside the S&T Power Supply Equipment room on which the power supplies from various sources viz. UP AT, DN AT, Local supply, DG set (as applicable) will be terminated. The Contractor shall coordinate with the contractor of CP 204 for above works.

(5) The Contractor shall take the Power supply from ACO to the main AC distribution panel/box common for Signalling and Telecommunication system on two independent power cables laid through diverse routes.

(6) The Contractor is required to create MCB protected 230 V, 50 Hz supply for the Signalling and Telecommunication system with sufficient capacity plus an additional 30% spare capacity for future expansion to meet the system design requirements.

(7) The Power Supply for Signalling system shall be drawn from Main AC Distribution Panels/Boxes and terminated on Signalling AC Distribution Panel/Box from where it shall be distributed to all Signalling Equipment/Signalling Power Supply Equipment operating at 230 V AC.

(8) The Contractor shall carry out a detailed power supply calculation for total Signalling load (including load of battery charging in boost mode) of every Station/ Auto Location/LC gate etc. and depending on the load requirement at each location, an Integrated Power Supply (IPS)/Uninterrupted power Supply (UPS) system of appropriate capacity shall be provided. The TMS system in OCC shall be provided with UPS of suitable capacity based on the load requirement at the OCC.

(9) All design loadings and calculations are subject to acceptance and approval by the Engineer before installation commences.

(10) The IPS provided shall be as per specification RDSO/SPN/165/2012 and procured as per Para 4.2 of this specification. The UPS provided shall be as per specification placed at Appendix 2. The supply to different Signalling equipment say Electronic Interlocking, Digital Axle Counter, Relays Internal, Relays External, Point Machine, Data Logger, VDU, Block Panel etc. shall be separate, provided using separate set of additional power supply equipment with minimum N+1 redundancy. The additional power supply equipment shall be in accordance with IRS/RDSO specification (if any)/ relevant international standards.

(11) The battery backup shall be provided with VRLA maintenance free cells as per specification IRS: S 93/96(A) of suitable capacity and procured as per Para 4.2 of this specification. Battery bank shall have adequate capacity to provide a backup time of minimum 4 hours with maximum depth of discharge of the battery as 70%. The batteries shall be installed on battery racks.

(12) Four numbers of 2V Cells and a spare Cell charger for charging up to 6 cells at 10% of battery AH capacity shall be provided as spare at each power supply location with the main supply.

(13) Restoration of the primary supply shall cause a seamless changeover from the IPS/UPS back to the primary supply.

(14) The Contractor shall sectionalize the power feeds to logical groups of equipment to allow for ease of maintenance and to enable maintenance to be carried out without disturbing the operation of other equipment groups.

(15) All Signalling equipment local supplies shall use redundancy techniques (ring circuit) to provide appropriate availability. The design of the distribution shall ensure that a technician can isolate the power feed to an item of equipment without affecting the operation of other equipment/items connected to the ring.

(16) An external bypass facility shall be incorporated in all IPS/UPS battery power supplies to cater for maintenance and failure requirements.

(17) Automatic monitoring of battery condition and charge state shall be provided as per Para 2.2.10 of this specification.

(18) All feeding voltages shall be monitored continuously by voltage sensors. In addition all non-earthed output supplies shall be monitored by earth leakage detectors. The said monitoring shall be possible from Service & Diagnostic (S&D) terminal at the station and OCC for which necessary sensors and interfaces shall be provided.

(19) Any failure of power supply equipment shall be recorded and displayed on the Control terminal at the Station and S&D terminal at the Station and in the OCC.

(20) Notwithstanding anything contained in this specification, the contractor shall be fully responsible for proper working of Signalling power supply system.

2.2.10 Service and Diagnostic System

(1) **System Requirements**

(a) A Service and Diagnostic (S&D) system shall be provided for monitoring and supervision of health of Signalling equipment and enable carrying out maintenance of Signalling equipment with optimum manpower and reduce the MTTR of the equipment.

(b) This system shall be able to anticipate, where practicable, failure of the equipment based on the deterioration of the parameters being monitored, thereby avoiding a potential future failure of Signalling system.

(c) The S&D terminals shall be provided with the Signal Maintainer at the Stations and with the Signal Fault Controller at the OCC. Each Signal Maintainer's S&D terminal shall monitor health of Signalling equipment under his area of control.

(d) The S&D computers shall analyze, link and evaluate indications such as status, fault, and event indications. With the help of such analysis and the specific fault conditions, the S&D computer shall identify the displayed faults. These faults shall be stored in a data-base separate for each system. Eliminated faults shall be stored for statistical evaluation at a later stage.

(e) The system should create alarms and reports for equipment maintenance and trouble shooting. It shall also be possible to send the alarms in the form of SMS to technicians in the field from the OCC. The Contractor shall provide the necessary hardware and software for the same.

(f) A soft copy of maintenance manuals shall be available on the S&D workstation, which the maintainer can refer during fault diagnostics and rectification.

(g) All Signalling 'As Built' drawing and documents of concerned station and adjoining block section shall be loaded on the S&D workstation of the station in pdf format. The S&D Server at OCC should house the 'As Built' drawings and documents of the entire Mughalsarai- New Bhaupur section.

(h) The Signalling system shall indicate within 2 seconds, certain functions, but not limited to the following:

(i) Identification of failure of point throwing or detection.

(ii) Identification of signal defects.

(iii) Power supply defects including IPS/UPS defects and earth faults.

(iv) Untimely or out-of-sequence operation of equipment.

(v) Unauthorized or potentially unsafe train movement.

(i) Following Typical alarms (but not limited to) shall be generated by the system:

(i) Point machine:

- Point obstructed.
- Point machine drawing more than normal current.
- Operating voltage drop at point machine is high. .

(ii) Axle counter:

- Evaluator operating voltage low.
- State of reset.
- PCB failure.
- Abnormal movement.

(iii) Power supply system:

- Presence of input supply from AT 1 and AT 2 on ACO
- Presence of output supply from ACO
- Input mains voltage beyond limits.
- Output voltage beyond limits
- Battery charger output not available
- Working on standby system after main system failure.

(iv) Earth Leakage Detector [ELD] for cable health monitoring:

- Supply leakage occurred time.
- Supply leakage disappeared time.

(v) Linking the events of supply application and withdrawal to cable conductors with ELD alarm.

(vi) Signalling Equipment room door monitoring

- Room opening and closing events.

(vii) Block instrument:

- State of the block section relating with block instrument.
- Wrong sequencing of block operations.

(viii) Battery Monitoring Unit:

- Cell voltage beyond limits.
- Battery charging and load currents beyond limits.
- Each cell temperature beyond limits.
- State of charge of battery bank lower than the limit set.

(ix) Colour light LED Signal:

- Current drawn beyond range.
- Signal lamp lit due to faulty voltage.

(2) **Technical requirements**

(a) Parameters of each Signalling equipment/ system shall be monitored by monitoring the voltages, currents, potential free contacts etc. using a general purpose data logger. In processor based equipment like Axle counters, Electronic Interlocking etc., the data logger shall collect the diagnostic data in soft form through a port in the equipment. Scanning interval for digital inputs shall be less than 20 milliseconds.

(b) The Service and diagnostics (S&D) data network shall be established by networking all data loggers using copper quad cable or OFC channels or dark fibres as appropriate and data of all stations and block sections shall be brought to Signal Fault controller in OCC on the OFC network provided under PS (Telecommunications) Vol. 3, Part 2, Section VI.

(c) The Data logger networking system at OCC shall consist of Servers, LAN Switches, Central Monitoring Units, Front End Processors, S&D terminal etc. with redundancy provided for each equipment. The VDU for S&D terminal at OCC shall be of minimum size 32".

(d) The Event Log should be automatically backed up by the system with a 60 day archive back up and that the active storage period is a rolling 30 days period.

(e) The S&D terminals shall be Industrial grade PC with a low noise logging printer of the latest technology provided at all stations and at OCC.

2.3 Train Management System

2.3.1 General Requirements

(1) The Train Management System (TMS) shall be a computer based train traffic supervision system operative from the Operational Control Centre (OCC) located at Allahabad. It shall automatically perform routine data logging and recording also to assist the operators.

(2) The system shall collect Signalling information from various Station and Auto Location Huts interlocking system on a real time basis. It shall also collect the train identification information from either Time Table or normally keyed in by the appropriate Controller/ Station Master.

(3) The system shall be able to detect train circulations by a logical sequence of track sections occupancies and releases. By assigning suitable numbers to these circulations it shall detect and track the trains.

(4) The system shall detect and manage alarms and logs generated in the system.

(5) The system shall enable interconnection with other TMS systems of adjacent sections/backup OCC/ OCC which will be provided by other contractors.

(6) The system shall have all the capability built into it to be configured at a later stage for remote control of Signalling System for use as Centralized Traffic Control (CTC) System from OCC with minimum configuration changes and no hardware add-on. Alternatively it shall be possible to control the TMS provided in this contract from CTC in OCC provided by other contractor. The Contractor shall seek clarifications in this regard from the Engineer in the early stages of the project. The decision of the Engineer in this regard shall be final.

(7) The system shall be designed to be Modular, Robust, Scalable, Fault tolerant and based on Open architecture.

2.3.2 Functional Requirements

The TMS shall provide the following main functionalities:

(1) **Signalling Indications management**

(a) The TMS display components like Video Wall Display System at OCC and TMS Terminals in the OCC and other locations shall show real-time geographical representation of the complete Signalling System of Mughalsarai- New Bhaupur section, including single line tracks connecting DFCCIL Junction Stations to IR Stations. In order to show the Signalling indications of boundary sections/IR stations, the TMS shall interface with other systems at boundaries to get their status on the displays.

(b) The display views shall be configurable. It shall be possible to use all monitors for observation of the Signalling system or use one or more monitors for other functions e.g. train graph, alarms, etc.

(c) While the display views on Video walls shall normally show panoramic view of the section with train identifiers and Signalling status, the display views on the controller's work station shall show more detailed view focusing on part or single Stations/Block sections. The dynamic indications shall be updated in real time.

(d) The display shall be designed so as to achieve the overall objective of providing instant information for providing a significant action when necessary. The vital response times between a change of state and its display shall be considered in design to meet this requirement.

(e) The Video Wall Display system for Signalling system shall display schematic of track layout, important indications of Station Control terminal, Signal aspects, Points, Track sections, LC gates, EIs, other infrastructure details like stations/bridges etc. (The Engineer shall select which of the indications are to be treated as important).

(f) The Video Wall Display Panel for Signalling system shall also provide alarm indications for failure of points, signals, track sections and other equipment failures as decided by the Engineer.

(g) For providing real time status of complete Signalling system, Train Management System shall automatically acquire data pertaining to status of Signalling Functions/Equipment. Following indications in additions to those normally provided on Video Display walls shall be provided on various TMS terminals.

(i) Signal aspects,

(ii) Points position,

(iii) Route Set/Release status,

(iv) A/AG Marker status

(v) Track section vacancy status for main and supervisory system, - Clear/Occupied/Error

(vi) Signal Failure,

(vii) Points Failure,

(viii) LC Gate Open/Close/fail,

(ix) Power supply failure

(x) ELD, Alarms,

(xi) Current Train locations

(xii) Train numbers and timetable deviations

(xiii) Temporary speed restrictions

(xiv) Any other indications

(h) Live indications to be provided to various controllers shall be based on their operational roles and these display views shall be configurable.

(i) The Contractor shall analyze Signalling indications displayed on various displays provided in TMS of other sections of EDFC and shall ensure similarity to the extent possible.

(j) It shall be possible for the TMS to send/receive the Signalling indications of its section to/from TMS of other sections of EDFC, as per interface agreement at Para 2.3.10 (4) of this specification.

(2) **Train Describer**

(a) The Train Describer System is responsible for real time management and tracking of all train information relevant to the train movements. More precisely it shall allow to:

(i) Associate a train number to each train;

(ii) Process the train stepping depending on the wayside equipment status and on the verification logics;

(iii) Provide information to Man Machine Interface (MMI) functions in order to represent graphically the train position; and

(iv) Delete the train number when the train leaves the territory.

(b) The Train Describer System shall associate a train with a unique alpha-numeric ID called a Train ID consisting of up to 8 alphanumeric characters displayed in a text box. This Train Describer System shall enable identification of all trains with Train ID as they move, and display real time information of their position and movements in sections monitored by TMS on Video Wall Display Panel and TMS Terminals. The Train ID together with colour/image of text box containing it shall enable identification of trains as per their loads like Container, Petroleum products, food grains etc. The Contractor shall use the same Train ID numbering scheme as used in the TMS of EDFC Phase 1.

(c) Train Describer System shall facilitate dispatch of Train from TMS Terminal of Station Master or traffic controller. Options of Scheduled Dispatch and Special Dispatch shall be available. For Scheduled Dispatch, the window shall list pre-stored Train ID to be selected along with editable Scheduled Departure Time and Destination Station from Timetable stored in Central Server. For Special Dispatch it shall be possible to enter Train ID along with other information such as Destination Station, Type of Load, Crew details

etc. The scheme for the menu driven commands shall be designed in consultation with the Engineer.

(d) Train Describer System shall generate an audio visual Non-Descript Alarm (NDA) on SM's TMS Terminal as well as on Traffic Controller's TMS Terminal in OCC, if Train ID has not been selected/ entered by concerned Station Master.

(e) Generally Train ID is to be assigned only when a train enters sections monitored by TMS for the first time. Thereafter Train ID and associated information can be modified, only if required, from TMS Terminals of Traffic Controller or Station Controller. For the trains which originate in other sections, the Train ID shall be maintained or updated automatically without manual intervention when the train enters this TMS.

(f) The Train Describer System shall register following abnormal conditions in the Central Database:

(i) Change in direction of a Train.

(ii) Train Parting.

(iii) Unidentified Trains.

(iv) Trains passing a signal showing a Stop aspect.

(v) More than one train on the same Axle Counter Track section.

(g) Abnormal disappearing of Train ID shall generate an alarm and display it in different colour.

(h) The Train Describer System shall be able to handle the commands for:

(i) Insertion of a Train ID on a track or at a signal, which shall be assigned automatically to the train occupying the track.

(ii) Moving a Train ID to a different location.

(iii) Renaming a Train ID.

(iv) Exchanging one Train ID with another train describer tag.

(v) Deleting a Train ID.

(i) It shall be possible to find the location of trains by search command. It shall also be possible to view list of trains in the Train Describer System with following criteria:

(i) All trains.

(ii) Only operator identified (known) train.

(iii) Trains in a given direction.

(iv) Trains at or between specific station(s).

(v) Unidentified or delayed or cancelled trains.

(j) The Train Describer System shall send log records of the events logged including the following information to Central Database:

(i) Movement of trains (Axle Counter Track Section to Axle Counter Track Section with timing).

(ii) Operator's commands to the Train Describer System.

(k) System will display crew details from the detailed link available in crew management software.

(l) The TMS shall exchange the Train ID and associated information with TMS provided in other sections of EDFC as per details given under Para 2.3.10(4).

(3) **Timetable management**

(a) The TMS system shall support the Timetable Management function so as to provide the information basis for the operation of the system during traffic hours. The Timetable Management function shall provide facilities for:

(i) timetable editing;

(ii) storing and managing different timetable versions;

(iii) loading of the appropriate timetable and creating an operational timetable.

(b) The Timetable Management functionality shall normally be operative from the TMS provided in EDFC Phase I by having TMS under this contract sharing all relevant databases of TMS of EDFC Phase I. However the TMS shall also have provision of its own Timetable Management functionality provided for the section covered in this contract required for use as per operational requirements.

(c) The TMS shall have capability to receive/send necessary Timetable data from/to TMS provided in EDFC Phase 1. The related database shall be shared by this TMS with TMS of EDFC Phase 1. The contractors shall interface and jointly agree on the format and protocols for data exchange as per Para 2.3.10 (4) of this specification.

(d) The theoretical timetable shall be created by an offline tool provided in TMS. Each train shall be assigned a unique Train Number and each train shall be defined with “time”, “location” and “dwell time” to identify start, finish and stopping for each section of the journey. The successfully created timetable files shall be uploaded in the TMS databases as required. It shall be possible to edit/modify the generated time table and test it on simulator terminal before loading it in the TMS system.

(e) The System should be able to automatically generate daily Time Table based on forecast of trains. Once the train enters the EDFC system, the system will generate a revised Time Table taking into account current train running, including any incidences of system degradation.

(f) The timetable format and the daily timetables shall be submitted for the Engineer’s approval.

(g) The loading of the appropriate daily timetable shall be initiated automatically on a daily basis, at a specific point in time.

(h) The system shall also enable the operator to load a new daily timetable manually.

(i) The timetable software shall automatically perform the reforecasting of the future train trips when modifications are being performed either by the operator or due to traffic perturbations.

(j) The System shall allow the time of loading to be reconfigured by the Software Technician.

(4) **Train Graph Function**

(a) The Train Management System shall also include Train Graph function for plotting and display of Train Graph. These Train Graphs shall be available at TMS Terminals provided with Chief Controller, Dy. Chief Controller and Traffic Controller(s).

(b) It shall be possible to create, modify and delete Controlled Area included in Train Graph from individual TMS Terminals.

(c) It shall be possible to edit the timetable graphically from the Train Graph display by drag and drop operations.

(d) Train Graph shall plot Time on X-Axis and Stations on Y-Axis. It shall be possible to define and modify scales of X and/or Y coordinates from individual TMS Terminals. The Train Graph Lines/Train ID Box shall have tag with details of train, crew etc.

(e) It shall be possible to show Schedule Time and the Actual Time in the same graph but with different colours.

(f) The Train Distance Graph shall allow for comparing the theoretical and the actual timetable.

(g) The Train Distance Graph shall highlight traffic conflicts and shall assist the regulator in identifying and implementing solutions to resolve conflicts.

(h) The system shall detect and resolve the following conflict situation: Same platform use, same route use, incompatible routes use, and same section use between two stations.

(i) It shall be possible to define and modify colour/image/numbers allotted for various type of Train Loads.

(j) On clicking/selecting a particular train on Train Graph, it shall give complete information about the train viz. Train ID, Crew Details, Load Details (e.g. Container, Petroleum Products, Food Grains, Coal etc.).

(k) Advance Charting: In case Controller defines the Maintenance Block on particular line for particular time, Train Management System shall be able to prepare Projected Train Graph showing advance/predictive movements of available trains in particular section.

(l) It shall be possible to deduce average speed of trains between any two stations.

(m) It shall be possible to take train frequency reports from the time table data base.

(n) It shall be possible to plot Historical Train Graph for selected period for analysis.

(5) **Event log and Alarm management**

(a) All important events such as command, indications, errors, system information, incidences etc. shall be logged in a database for record and analysis.

(b) An Event Logging function shall be implemented enabling the continuous record of all changes of state of the TMS system for maintenance and engineering purposes.

(c) The events (changes of indications, input of commands, alarms etc.) shall be time stamped to an accuracy of one second and recorded in the order of occurrence on a non-volatile media.

(d) The Event log storage capacity shall be initialized and the oldest events shall be overwritten by new events as they occur. Manual archiving by the operator shall also be possible.

(e) When the event storage capacity of the system is reached its content shall be automatically archived without affecting the normal operation of the system. This shall be prompted to the operator by a message.

(f) The Event Log should be automatically backed up by the system with a 60 day archive back up and that the active storage period is a rolling 30 days period.

(g) The Event log shall not be corrupted by power supply or system failure (other than of the event logging sub-system itself).

(h) Event logging shall enable quick and accurate review of past events and provide a concise picture for subsequent analysis in the event of an incident.

(i) The HMI shall support interactive functions for the viewing and processing of events. All events shall have a possibility to be directed to a printer and to archive by different criteria.

(j) The TMS system shall support the generation, display and processing of specific events related to the performance of the Signalling and Train management system.

(k) Alarms can be traffic related and can also be differentiated depending on the criticality of their impact and the action required by the user to resolve or acknowledge a specific alarm. As a minimum, the TMS system shall support three classes of alarms, as follows:

(i) Emergency, i.e. alarms with highest priority, which require acknowledgement and an action to be taken by the operator;

(ii) Urgent, i.e. alarms with medium priority, which only require an acknowledgement;

(iii) Non-urgent, i.e. alarms with low priority, which are for information only.

(l) The Contractor shall propose for the acceptance of the Engineer lists of events that shall be identified as emergency, urgent and non-urgent alarms.

(m) The alarm class shall determine the manner in which the alarm is enunciated, displayed and logged. Alarm parameters should be modifiable at the Software Technician's Console and the classification shall be approved by the Engineer.

(n) Alarms shall be displayed to the operator in a clear and consistent way, which shall be guaranteed to bring his attention.

(o) Following Traffic Related Alarms shall be recorded and displayed on TMS Terminals of Traffic Controller, Signal Fault Controller and concerned Station Master:

(i) Failure of any Signalling Equipment including Electronic Interlocking, Power Supply, Axle Counter, Signal Lamp, Point Machine etc. in the entire section under scope.

(ii) Routes not released after passage of train.

(iii) Train passing Signal at Danger (SPAD).

(iv) Train Non-Descript Alarm (NDA).

(v) Train waiting for more than 5 minutes at a manual stop signal not taken off.

(vi) Train stopping at OFF signal for more than 5 minutes.

(vii) Any other unscheduled train stoppage.

(viii) Any unscheduled train detention in excess of prescribed time.

(ix) All the above Traffic Related Alarms shall be arranged in priority levels to be decided in consultation with the Engineer.

(x) It shall be possible to prepare Traffic Related Alarms Reports in formats to be decided in consultation with the Engineer.

All alarms not directly related to traffic operations shall be considered to be Network related alarms. Failure of Network Communication / inability to access any of the TMS nodes, defective terminals and hardware & software failures shall initiate Network related alarms. These Network Related Alarms shall be displayed on the TMS Maintenance Terminal in OCC. These shall be arranged in priority levels to be decided in consultation with the Engineer.

(p) The user should be able to acknowledge, delete and retrieve alarms.

(q) The operator shall be able to acknowledge alarms individually or by a group. When the operator acknowledges an alarm the TMS system shall log into the Events Log and the Alarms Log a message containing the operator ID, the alarm identification and the time of acknowledgement.

(r) No alarm logging information should be lost due to communication faults or processor failures.

(s) Facilities shall be provided for all alarm messages to be logged into the Events Logs and/or a separate Alarms Log and to be archived.

(t) The TMS shall be able to respond to any query for alarm logs from TMS of other sections of EDFC, whenever required. The TMS shall be able to exchange the data with Central servers of other TMS for the same.

(6) **Crew Management**

(a) The Crew Management functionality shall normally be operative from the TMS provided in EDFC Phase 1by having TMS provided under this contract sharing all relevant databases with TMS of EDFC Phase 1. However the TMS shall also have provision of its own Crew Management functionality provided for the section covered in this contract.

(b) The TMS shall provide the Crew Management System functionality for the management of crew running on Mughalsarai-New Bhaupur section of EDFC. Terminals of Crew Management System shall be provided at Crew Control Lobbies/Crew Booking points. In addition some functions of Crew Management System shall be available in TMS Terminals of Chief Controller, Dy. Chief Controller, Traffic Controller and Station Master.

(c) The Crew Management System shall give real time position of Train Running Crew with details of Train and Location.

(d) The Crew Management System shall have provision for creating database records of Train Running Crew. The database records for train crew shall normally consist of fields like crew member name, emergency contact (phone, mobile number), qualifications etc. The database shall also have all the information related to Personnel, Safety and training (like refresher due) of all Train Running Crew. It shall be possible to import crew data in a predefined file in the TMS system format as agreed with the Engineer.

(e) As a part of the Crew Management functions, the crew operator shall have the following operations

(i) Create, add, remove and modify the crew member database

(ii) Create plan that associate On duty crews to generate a Link programme based on data fed for Train Running crew for a predefined period of time ahead

(iii) Modify the above plans before start of daily operations based on crew members availability

(iv) Modify the above plans on abnormal incidences like train delays

(f) The System shall be able to import a roster plan. Roster plan shall associate Duty No. to every trip, provide the sign on/sign off time, break time & counselling time for each duty no. System shall also check for any conflict in the duty no. with respect to trips.

(g) The System shall give crew suggestions, based upon agreed parameters, for the upcoming trips in case of delay in the train running or train reformation; and shall also allow the change manually.

(h) The System shall have provision to enter Train Running Crew Booking Details manually at Crew Control Lobby/Crew Booking Points for predefined period ahead. Deviation for the booking schedules shall be entered by Crew controller on train to train basis. It shall also be possible to change the names of Train Running Crew, when prompted to do so by Central Server.

(i) The System shall also have provision to generate a Link Program based on data fed for Train Running Crew. It shall be possible to change Train Running Crew booking details for next 24 hours as shown in the generated Link Program.

(j) The TMS shall automatically take the Train Running Crew details from the Link Program (with suitable tag that data is from link table) or the online data fed by Crew Controllers at Crew Control Lobby/ Crew Booking Points.

Getting daily report of planned booking and actual booking of Train Running Crew shall be possible. Generation of Monthly Reports of individual Crew in terms of daily KMs, Duty Hours, train on time performance etc. shall be

possible based on real time data from TMS. It shall be possible to get driving report for individual running crew. The various Report format shall be finalized in consultation with the Engineer.

(k) The Crew Management System must be closely integrated with TMS to reap the benefits as indicated in paras above.

(l) The Crew Management System Screen shall be menu driven with multiple windows. The details of screen and procedure shall be decided in consultation with Engineer.

(m) The TMS shall be required to send/receive the details of the Crew management information with the Central servers of TMS of EDFC Phase 1. The format of the exchange shall be jointly agreed between the Contractors.

(7) **Management Information System**

(a) The system shall generate report of trains running late by pre-prescribed reference.

(b) Based on the events logged and the operator input, the system shall generate the following (but not be limited to) reports:

(i) Punctuality report - daily, weekly or monthly as per prescribed format.

(ii) Bad runner report.

(iii) Train Composition report.

(iv) Analytical report of various unusual occurrences, i.e. Signal failures, OHE breakdown, Loco failure, Sick wagons etc. This can be again generated on daily, weekly or monthly basis on prescribed format.

(v) Analytical report of crew link/ utilization.

(vi) Total Maintenance Blocks granted / refused along with locations, time blocked, time cleared.

(vii) Sectional running time taken by trains of any ID.

(viii) Delay report of trains along with train Nos., time delayed (at stations/mid-section) etc.

(ix) Difference between actual and scheduled running time in tabulated as well as in graphical form.

(x) Loss on account of imposition of speed restrictions.

(c) The system shall allow user to create an unusual report, describing a failure and the trains that were affected by it.

(d) The system shall allow user to enter any free text tag to be associated with any train.

(e) The reports shall be generated in designated formats.

(f) Report formats shall be customizable.

(g) Provision shall be made for the basic data reports to be exported to other systems in different formats so that they can be represented as necessary.

(h) The TMS shall be required to send/receive the details of the Management information system reports with Central server(s) of TMS of other sections of

EDFC as per Para 2.3.10 of this specification. The format of the exchange shall be jointly agreed between the Contractors.

(8) **Simulation and Training System**

(a) Separate Servers and terminals shall be provided for Simulation studies, Playback, and Training purpose at OCC. The replay of log, training to operators, time table testing etc. shall be possible from these terminals and associated servers.

(b) It shall be possible to test generated/edited Time Table on Simulation System Software.

(c) Simulation System shall be suitably integrated with TMS Central Server for transfer of the tested Time Table. This transfer shall be possible by authorized user only.

(d) Through Simulation System Software, it shall be possible to simulate and observe the effect of various parameters such as Maintenance Block, Speed Restrictions, Change in Yard Layouts, Addition/Deletion of Signal, Train speed, Dwelling Time etc. on Section Capacity and to produce effected Working Time Table and Train Graphs. These parameters shall be determined in consultation with the Engineer.

(e) Simulation System Software shall facilitate simulation of train movements by occupying & releasing Axle Counter Track Sections in accordance with movement of trains.

(f) Simulation System shall be suitably integrated with TMS Central Server and its Database for downloading a copy of Events Logs & Alarms for predefined/selected duration in its own Database.

(g) The simulation of downloaded Events Log & Alarms for replay shall be possible. This simulation shall be possible in real time or in reduced/accelerated time scale. When the replay is started, the dynamic status for infrastructure, Train ID, Alarm List as well as the pictures on the screen shall be initialized. It shall be possible to perform studies on this simulation by changing various dynamic parameters such as Speed Limit on Signals, Temporary & Permanent speed Restrictions, Braking Characteristics, Driver's Reaction time etc.

(h) The Simulation System Software shall be capable of simulating the existing Time Table and compare it with actual running on periodic basis to create Management Information to identify any shortcomings in the System/Time Table.

(i) Simulation System shall also be used for imparting training through terminals provided to Trainer and Trainees. Details of facilities and features available on these terminals shall be decided in consultation with Engineer.

(j) It shall be possible to configure Trainer's terminal to work as active Traffic Controller's TMS Terminal in case of any of the Traffic Controller's TMS terminal becomes defective/out of service.

(k) The Playback functionality shall be provided to truly reproduce what has happened on the real application during a definite time period in the past. By means of the playback it shall be possible to replay what has happened and analyze the different situation in terms of both system behavior and Section

Controllers operations. The playback reproduction shall be possible from any workstation on which playback functionality is available.

2.3.3 System Architecture and Design Requirements

(1) The TMS system architecture shall be defined in conjunction with the type, architecture and design of the vital Interlocking System(s) and the designated interlocking areas.

(2) The architecture shall utilize local intelligent units, coordinated by a central computer with highly reliable and redundant communication channels.

(3) While the interlocking system(s) and the TMS will be closely interrelated from an operational point of view they shall have clearly defined interfaces so as to eliminate any possibility of a failure in one of the interfacing systems causing a malfunction or affecting the performance of the other.

(4) The interfaces shall be so defined to:

(a) Enable the TMS system to operate at high levels of functionality with minimal risk to safety;

(b) Enable to keep to the minimum the complexity of the vital interlocking system;

(c) Facilitate validation, testing and fault finding.

(5) The Train Management System shall, broadly comprise of, but not limited to, the following:

(a) Central Server(s) at OCC.

(b) Simulation Server(s) at OCC.

(c) Communication network and Communication front end server(s)(Optional) at OCC.

(d) Video Wall Display System at OCC for Signalling and SCADA.

(e) TMS Terminals for Controllers at OCC.

(f) Terminals for Simulation, Time Table Planning and Maintenance at OCC.

(g) TMS Terminals for Station Master at Stations.

(h) TMS Terminals for Maintenance at Station, IMD & IMSD.

(i) TMS Terminals for Crew Management.

(j) TMS terminals for Miscellaneous Users.

(k) Communication Network & Way Side Communication Equipment at Wayside EI.

(l) TMS System Software.

(m) Printers, Plotters, Cables, Connectors and other accessories.

(n) Interfacing arrangement with Traction Power SCADA system.

(o) Interfacing arrangement with Master Clock System.

(p) Interfacing arrangement with TMS of adjacent sections and Backup OCC.

(6) The architecture shall incorporate sufficient level of redundancy to ensure the required availability, as specified under Para 3.6.4 of this specification.

(7) The TMS System shall have inbuilt redundancy in the software and hardware at OCC as well as at the wayside locations including all servers, communication network equipment and links/channels such that a failure of single component of the TMS system does not lead to loss of overall TMS functionality.

(8) The TMS system shall be structured in such way that in the event of a single hardware or software module failure, full system functionality shall be automatically restored upon rectification of fault within such time as to achieve the required system performance criteria.

(9) The TMS system shall be designed to use not more than 40% of the available CPU in normal operation and not more than 60% of the CPU in rush hour,

(10) The TMS system designed and implemented shall be flexible and modular enough to permit easy alterations/changes in terms of change in site data, addition or deletion of user, stations etc. and for easy reconfiguration to take into account future software/hardware developments.

(11) The TMS system is intended to be used in 24/7 mode. Hence built in features/strategies should ensure that the system is available on a continuous basis. Particular care should be taken during system design in selection of components that ensure specified availability for the TMS.

(12) The System shall be designed to achieve the overall objective of providing real time information related to train operation. The response time between a change of state of Signalling equipment at a wayside station and its display at OCC shall not be greater than 2 seconds.

(13) TMS Capacity

(a) The TMS system shall have adequate capacity to handle data for running of 8 trains per hour in each direction during normal operation and 12 trains per hour in each direction during rush hour.

(b) The TMS system shall be designed to have a 20% expansion capability beyond what is specified at (a) above.

(14) Sufficient Memory and related resources shall be provided to enable the implementation of additional displays consistent with the requirements for extension of the system.

(15) There shall be provision of network based printers in OCC for printing various reports and logs. Three numbers of A3 colour laser type printers shall be provided in the OCC. There shall also be a provision for A0 plotter for plotting various train charts/graphs. At every station with TMS terminal one A3 colour laser printer shall be provided. 5 nos. of A3 printers shall be separately provided whose location shall be specified by the Engineer.

2.3.4 Features of TMS terminals

(1) **Common features of TMS terminals**

(a) For standard monitoring, supervision and control purposes all operator interfaces to the TMS system should be through universal type of workstations (TMS terminals) which can be easily configured to required operator functionality based on the users log in profile. Irrespective of whatever may be the operational role of user, the TMS terminals shall have the same look and feel to maximize the operational synergies between the various operator roles.

(b) All the TMS terminals shall show the real time display of train movements and status of Signalling infrastructure.

(c) All user initiated functions shall be accessible using Mouse & Key Board. It shall be possible to enter commands through menus, selection in the pictures, functional keys or via text input through GUI based user-interface. The precise operation of objects and the content of menus must be as agreed with the Engineer.

(d) It shall be possible to scroll from left to right and vice versa from one station to another without flicker. In case of big yards with a number of lines, the yard shall not look congested on the screen. In addition, it shall be possible to divide the bigger yards into suitable no. of pictures.

(e) It shall be possible to open many windows on each terminal. A window must be active when the cursor is moved in its frame and the operator must be able to issue commands only to those objects in active window. The display shall be dynamic even if the related window on the screen is not active.

(f) The various input displays and reporting formats (to be decided in consultation with Engineer) shall be used for dialogue between the operator and the terminal.

(g) It shall be possible to mute the audio or change the volume. It shall be possible to alter the viewing angle of the VDU monitor in the vertical and horizontal planes.

(h) Current time and date shall be continuously displayed on the VDU screen conspicuously. Furthermore, the display shall be provided with an indication, which ensures the VDU screen is communicating in real-time and is not “frozen”

(i) In case of unusual events, the system shall prompt the controller to enter the reason and other details in the prescribed format. This shall form part of database and shall be used for MIS reports later.

(j) Any failure or unusual event will generate an audio/visual alarm as per user requirements to draw attention of the operator. It shall be possible to acknowledge and stop the alarm of failures by the user.

(k) Authority to log in shall be protected through a password. Only authorized persons shall be able to log in and access related database.

(l) Access to the server’s application software & system software shall be restricted through the gateway and proper authority check.

(m) The Contractor shall to the extent possible design the user interface of the TMS terminals, similar to the user interface of TMS terminals provided in EDFC Phase 1.

(2) **Specific Features on various TMS terminals**

(a) **TMS Terminals for Controllers - Chief Controller, Dy. Chief Controller, Traffic Controller(s) and Assistant Controller**

(i) These TMS terminals with each of the Controller shall have three monitors, one will show the overview, another the detailed view and the third one would show the alarm/event view. There shall be full

flexibility, however with regard to display of information on any of the 3 monitors.

(ii) TMS Terminal shall facilitate all functions of Train Describer System as mentioned section 2.3.2 (2).

(iii) All the Traffic related alarms described in section 2.3.2 (5) shall be available on these terminals.

(iv) The crew details available in the system shall also be available on these terminals, apart from being available on the TMS Terminals of Station Masters and Crew controllers.

(v) It shall be possible to view Train Graphs be it historical, previous or current. The Train Graph shall also cover advance charting showing traffic blocks. Messages/Information of diversion/cancellation of trains issued from these Terminals will draw attention of SM by flashing audio visual indication.

(vi) The Traffic Controller shall be able to enter any inputs regarding rescheduling of trains. This data shall be considered temporary and the operator shall be prompted to input the duration for which the data shall be held valid.

(vii) The temporary valid data shall be given the same status as that of permanent data and all the time tables and trains graphs shall be generated as per this data.

(viii) It shall be possible to view various MIS reports.

(b) **TMS Terminal for Signal Fault Controller at OCC**

(i) Remote monitoring of status of Signalling equipment at stations and in Block Sections, shall be provided on these terminals. This shall include logging in of events in central system, generating alarms, alerts etc.

(ii) Signalling equipment failure alarms as decided by the Engineer along with category shall be available on the terminal. It shall be possible to acknowledge the alarms by the user.

(iii) All Traffic related alarms also shall be available on these terminals.

(iv) It shall be possible to gain access to all reports as can be accessed by the Traffic controller(s).

(v) All the formats for the displays /reports shall be decided in consultation with the Engineer.

(vi) It shall be possible to send message to the other controllers through the terminal by video flash /audio buzzer.

(vii) Facility of viewing the train graph on the same monitor shall be available on these terminals.

(c) **TMS Terminals for Track Controller and Traction Power Controller at OCC**

(i) It shall be possible to input remarks / information pertaining to various unusual occurrences e.g. failures & delays to operation etc.

(ii) It shall be possible to gain access to all reports as can be accessed by the Traffic controller.

(iii) It shall be possible to access the Central server for retrieving reports in suitable format. All the formats for the reports shall be decided in consultation with the Engineer. System will have a provision that a report retrieved by a particular controller pertains to him only.

(iv) It shall be possible to send message to the other controllers through his terminal by video flash /audio buzzer.

(v) Equipment failure alarms specific to Track or Traction Power, as decided by the Engineer along with category shall be available on the respective terminals.

(d) **TMS Maintenance Terminal at OCC**

(i) The Maintenance Terminal shall be used for supervisory functions of the network and for observing any required nodes and their configuration at any time.

(ii) It shall be used for indication of all alarms, both operator related and network related.

(iii) It shall be possible to bypass any node if so required and configure other terminals from this terminal.

(iv) It shall have fault logging & diagnostics for network equipment at element level.

(v) Displays of equipment faults, communication failure occurring anywhere in the OCC or field network shall be readily available on this terminal.

(vi) In case of faults, this terminal shall provide all assistance for rapid detection of faults.

(vii) Alarms shall be available on this terminal as per categorization in 2.3.2 (5) and few of the Emergency Alarms are as follows:

- Power supply failures at control centre, station, block section location or any node in network.
- Central control internal communication failure.
- Communication equipment failure.
- Field control unit failure.
- Failure of nodes.
- System failure.
- Interlocking interface failure (Way Side Communication Equipment).
- Any other indication considered essential by the Employer.

(viii) Alarms shall be logged on real time basis. These shall be recorded in format so as to access particular file as required at a later date. Exception report (failure report of desired elements) shall be generated. File format shall be decided in consultation with the Engineer.

(ix) This terminal shall have access to MIS reports.

(x) Terminal will provide a pop up window to display a table to allow maintainer to correlate data communication with its associated field objects. Also, online display about the following shall be available:

- Station being polled.
- Station transmitting.
- Station faulty.

(xi) Element level Network Management System (NMS) module shall be available on this terminal and shall show:

- The position of various nodes.
- Identification of faults and their nature.
- Current status and health of equipment and communication channels.
- Memory utilization.
- Remote bypassing and changeover of faulty equipment.
- Ability to check quality of communication from any node to the other on the network including bridges and routers. This shall be done in background without visibly downgrading the system.

(xii) Facility to view system / network performance statistics on this terminal shall be provided. From this terminals other work station computers, terminal servers, voice and data switching nodes and SM terminals shall be able to be monitored at element level for performance and switching to alternate communication channel.

(xiii) It shall be possible to monitor all elements of network of OCC and field units through NMS.

(xiv) SNMP or a similar standard protocol as approved by the Engineer shall be used.

(xv) It shall have facility for real time diagnostics of Communication network automatically as well as manually.

(xvi) Facility for Network performance statistics, communication testing and managing internal or external node on the network shall be made available.

(xvii) Fault Diagnostics

- All malfunction in vital hardware subsystem/ modules in the OCC shall result in audio & visual alarm at the maintenance terminal.
- The maintenance terminal shall have diagnostic software through which it will periodically scan all elements.
- Diagnostic routine to check hardware like TMS field equipment (excluding interlocking installation) and data communication circuits shall be available.
- Shall have monitor programs to test connectivity.
- Facility shall exist in the system to switch from one communication line to the other in case of fault.
- It shall be possible to display polling status of stations.

- It shall be possible to capture all transmission events for analysis and fault finding of data transmission.
- It shall be possible to change the password configuration of the Controllers /SMs terminals.

(e) **TMS Terminal for Station Master at Station**

(i) One TMS Terminal for Station Master at every Station shall be provided.

(ii) TMS Terminal for Station Master shall facilitate all functions of Train Describer System as mentioned in Clause 2.3.2 (2)

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

(iv) The details of occupancy of berthing lines and sidings shall be available. Details of loads available on sidings at concerned station shall be displayed when cursor is placed on the siding. Whenever a train leaves / enters the control area or is put out of the system by placing it in the siding it shall be automatically registered by the system. In addition to this, SM shall have facility to delete / enter such trains. Whenever a train / load leaves /enters the control area of concerned station or is put out of the system by placing it in the siding the SM shall have facility to delete / enter such trains from / into the system.

(v) Flashing messages/instructions from the controller and information about expected arrival of next two trains on each line, cancellation and diversion of trains shall be displayed.

(vi) It shall be possible to view various MIS reports.

(vii) Communication arrangements available at the station shall also be displayed symbolically.

(viii) It shall be possible to send pre-defined routine messages by the Station Master to Central server either pre-stored or entered through a dialogue box.

(ix) Crew details information shall also be available with these terminals.

(f) **TMS Terminal with Signal Maintainer at Station, IMD and IMSD**

(i) The alarms for failure of vital Signalling and Power Supply Equipment in the jurisdiction of Station, IMD and IMSD shall be available on the terminal.

(ii) Traffic related alarms shall also be available on these terminals.

(iii) It shall be possible to view various MIS reports as agreed to by the Engineer during design stage.

(iv) Facility of sending the messages to Central controllers including the signal fault controller shall be available on these terminals.

(g) **Miscellaneous User Terminal**

The Contractor shall provide 15 Nos. of Miscellaneous User TMS Terminals at important offices/locations. The locations will be IR stations, IR Divisional

and Zonal office and DFCCIL Regional & Corporate office etc. as decided by the Engineer. The exact locations and features to be made available on these terminals shall be approved by the Engineer. These terminals will provide first-hand information about running of trains in visual form and in required format. While the terminals provided in the DFCCIL territory will be connected on Telecommunication System being provided under PS (Telecommunications) Vol. 3 Part 2, for the terminals provided in the IR territory the network and requisite Power Supply shall be made available by the Employer.

2.3.5 Software Features and System Administration

(1) As all data may not be available in a satisfactory format during the initial implementation of the system, it is necessary that provision exists for incorporating changes/amendments to the existing formats/presentation and for introduction of any new functionality. It is also possible that additional items/objects may have to be introduced in future, hence provision should exist for incorporating such items/objects.

(2) Modification and Alteration

(a) It shall be possible to add minor additional functionality (to be decided in consultation with the Engineer) or even extend the system to increase number of users by adding additional workstations without changing existing software.

(b) Following modifications shall be possible with password authentication without recourse to the source program (code).

(i) Managing the Users

- Ability to add users specifying their names, password & access level.
- Facility to delete an existing user.
- Change the priorities allocated to users.
- Stop / provide access to any of the modules.
- Change areas of jurisdiction.

(ii) Database Management

- Database administration.
- Edit database to change the names of locations, stations etc.
- Change status of stations.
- Introduce new stations.
- Introduce new objects and delete existing objects.
- Change details of objects.
- Amend / alter geographical layout at stations and in between stations.
- Change format of reports.
- Introduce new reports.
- Introduce/change/delete temporary speed restrictions.

(iii) Time Table Management

- Cancel a train.
- Insert an additional train.
- Change the destination of a train.
- Change the departure time of a train.
- Change the timetabled dwell time at any station for one train or all trains.
- Change timings of existing trains.
- Change the sequences of trains.
- Change various particulars of trains.
- Change the loco number vis-à-vis train number.

(iv) System Management

- Change priorities of existing alarms.
- Introduce new alarms with varying priorities.
- Changing the details of any node.
- Introduction of new nodes.
- Changing the displays on maintainer's terminal.
- Changing the printer / plotter parameters.

(3) System Administration

(a) A supervisor administration function to be exercised by a single nominated person shall, as a minimum, be available to control the following:

(i) Allocation of Passwords.

(ii) Creation and deletion of Users.

(iii) Administration and housekeeping functions.

(b) Functional and geographic partitioning shall be possible for different user profiles. The TMS shall have provision for following configuration changes :

(i) It shall be possible to partition the TMS system on multiple levels to control distribution of alarms and events and to provide security.

(ii) Partitions shall be used to determine if a particular alarm or event is routed to a specific MMI user and to validate if that user can execute a control or function.

(iii) The system shall support the division into functional partitions. Each functional partition shall represent a function such as Traffic Controller, Station Master etc.

(iv) The system shall support the division into geographic partitions. Each partition shall represent a geographically related group of assets.

(v) Each indication, control, alarm and user action shall be assignable to any one or multiple functional partitions.

(vi) Each indication, control, alarm and user action shall be assignable to one geographical partition.

(vii) Functional and geographical partitioning shall be assigned by TMS to a user based on logon information.

2.3.6 Technical Requirements

(1) **General**

(a) All Servers and Terminals to be provided at OCC shall be of same type and make as approved by the Engineer.

(b) All Terminals to be provided at wayside locations shall be of same type and make as approved by the Engineer. The hardware installed at wayside locations shall be modular and rugged and of appropriate size, capability and capacity.

(c) All Servers and Terminals at OCC & wayside locations shall be provided with printer slot and minimum 2 spare I/O slots for future use.

(d) Servers and Terminals shall be of Industrial grade. Vendor of Servers and Terminals shall have service centres in India.

(e) LED Indications and test points shall be available on various cards /Modules for easy fault diagnostics by the maintenance personnel.

(f) Field station hardware shall be housed in a 19" dust free, pre-wired rack.

(g) The system designed and implemented shall be flexible and modular enough to permit easy alterations/changes in terms of change in site data, addition or deletion of user, stations etc. and for easy reconfiguration to take into account future software/hardware developments.

(h) The TMS system shall support communication with neighbouring TMS based on UIC 407-1 or similar standards.

(2) **Central Server(s)**

(a) The following shall be the main functions of the Central server(s):

(i) It shall maintain and update in real time the position of all the TMS indications /information / all field nodes to the last second.

(ii) It shall provide drive for the Video Wall Display Panel. It shall display all the incoming information /data and shall revert back to the field nodes for incomplete information to ensure the latest information is obtained.

(iii) It shall accept input data from the authorized operator /node only. The access to the server shall be through a gateway with the correct level of authority. It shall process the data as per requirements of the system.

(iv) It shall reply to the queries requested by various SMs in the background without interrupting the Traffic Controllers.

(v) It shall provide necessary data to print the various reports in suitable formats.

(vi) It shall enable display of both information and alarms on any of the terminals in OCC, Station etc. as per pre-programming.

(vii) It shall be connected via data channels with the entire station signal interlocking through a suitable interface. The OFC/data channels for connectivity will be provided under PS (Telecommunications).

(viii) The aggregate information/ status of Track sections, signals, points, route set, LC gate closed/open etc. of station and block section shall be transmitted from wayside stations to Central server.

(ix) The Central server(s) shall also be interconnected to Central server(s) of EDFC Phase 1 for exchange of necessary data as per the interface agreements between the two contractors.

(b) The Contractor shall propose their own networking methods between field stations and Central server to achieve desired performance. All network elements shall be capable of being monitored and managed in the event of malfunction.

(c) It shall be provided with adequate flexibility so that alterations and additions to the present functions and facilities are carried out with minimum disruption in the working system as and when required. It shall be compatible with future interlocking changes/yard alterations at wayside stations.

(d) It shall be compatible for running off line forecasting module for computing expected arrival of trains.

(e) Central server equipment shall be fault tolerant system. It shall also be provided with Disc storage device to store real time database reflecting TMS information as well as an event logging database. Various terminal / equipment in the OCC office shall be interconnected with applications server using a dual local area network (LAN). Adequate redundancy of critical system, software and database shall be ensured.

(f) Central server shall have following minimum hardware configuration:

(i) Type: High end server.

(ii) Processor – Minimum 64 Bit, Multi Core Multi processor.

(iii) Speed - Minimum 2 GHz.

(iv) N+1 hot swap cooling.

(v) PCI-X 8/16 port.

(vi) Core PCI-X dual port 10/100/1000Base TX LAN (with auto speed sensing; RJ 45 connector, Wake On LAN support).

(vii) HDD - Minimum 8X146 GB, Hot swappable, Ultra SCSI with appropriate RAID configuration support.

(viii) Console - 32” colour monitor.

(ix) Hot swappable redundant power supply.

(x) I/O card - Adequate I/O facility.

(xi) Accessories - As required.

(xii) Supporting operating system – 64 bit

(xiii) Server shall be mountable on 19” rack.

(xiv) The hardware requirements described above are minimum requirements but are not definitive. The Contractor shall design and supply all hardware to fulfil all functionality, reliability and availability requirements as specified.

(g) The number of Servers and their configuration should be proposed by the Contractor. The Contractor must present RAMS analysis in order to demonstrate that the proposed solution satisfy the availability requirements."

(h) Central Server shall be provided in hot standby mode. The Standby server shall be exact replica of Main Server. In the event of problem with Main server, execution of application shall be seamlessly transferred to Standby server without interrupting the operation and affecting the quality of service of operation. Similarly, if system is running on Standby server and it fails, working shall be transferred to Main server. Central Server shall be capable enough to deliver the required performance. It shall be possible to disconnect the Standby server for repair/replacement without affecting the server in operation. The contractor may supply more than one equipment/set of equipment to achieve the required performance along with its hot standby.

(i) Logging of Data on Servers

Following data need to be archived for subsequent use:

- All train related information. (Signalling indications, train movements details, trains description details etc.)
- All system related data viz. node failures, hardware failures, communication failures etc.
- All inputs made by the way side terminals (inclusive of crew lobby/crew booking point) or by terminals at the OCC.
- The data shall be stored in a compressed and organized form so as to conserve the disc space.
- The storage shall be for a minimum period of 60 days.
- It shall be possible to take INCREMENTAL back up on hard disc. The Contractor shall provide additional hardware for this purpose.
- It shall be ensured that the data is not lost while copying.
- The notes recorded by the Section controllers/SMs shall also be logged on the storage devices. These notes shall be linked to the concerned screen and context.

(3) **Simulation Server**

(a) This Server shall be provided as a separate Server with its own LAN at the OCC or any other location as decided by Employer for training and simulation purposes as per following (but not limited to) details:

(i) One terminal with 3X32" (minimum) VDUs for Simulation and Time Table Planning.

(ii) Five terminals for Trainees with 1X32" VDU (minimum).

(iii) HDD - Minimum 2 X 64 GB, Hot swappable, Ultra SCSI in RAID 1.

(iv) It shall be possible to configure Trainer's terminal to work as active Controller's terminal in case of any of the Controller's terminal becomes defective/ out of service or any other reason.

(v) The hardware requirements described above are minimum requirements but are not definitive. The Contractor shall design and supply all hardware to fulfil all functionality, reliability and availability requirements as specified.

(b) It shall be possible to access the database for analysis and simulation studies. The data or results thus generated after simulation study or analysis shall not be stored on the main memory of the Central server permanently. To prevent the same, both hardware and software checks shall be provided. It shall be possible to store it in its own hard disc.

(4) **TMS Terminals Hardware**

(a) All TMS terminals shall have similar hardware configuration. Following Hardware Configuration shall be proposed :

(i) Type: Industrial Workstation.

(ii) Processor: 64 Bit Multi Core Multi Processor.

(iii) RAM: Minimum 8 GB.

(iv) FLASH MEMORY: Minimum 120 GB.

(v) Monitor: LED Backlit Colour monitor, high resolution 1920 X1200, 32" (minimum).

(vi) I/O card: Adequate I/O facility, Integrated Drive Controllers, Dual network Interface cards, High End Graphics card etc.

(vii) Accessories: As per requirement.

(viii) A printer shall be connected for on line logging with the TMS Maintenance Terminal for logging all network related alarms.

(ix) The hardware requirements described above are minimum requirements but are not definitive. The Contractor shall design and supply all hardware to fulfil all functionality, reliability and availability requirements as specified.

(b) Table below shows the various operational posts for which the TMS terminals are provided and the number and sizes of monitors with the controllers.

Operational Post	Monitor Size (inches)	No. of monitors per position
Chief Controller	32"	3
Dy. Chief Controller	32"	3
Assistant Controller	32"	3
Traffic Controller(s)	32"	3

TMS Maintenance Terminal at OCC	24”	1
Signal Fault Controller	24”	1
Track Controller	24”	1
Traction Power Controller	24”	1
Station Master at Station	24”	1
Crew Controller	24”	1
Signal Maintainer at Station, IMD and IMSD	24”	1
Miscellaneous User TMS Terminals	24”	1

(c) In the OCC separate workstations for offline timetable management shall be provided having the same configuration as those for TMS terminals.

(5) **Communication Network at OCC**

(a) Dedicated Communication Network at OCC for interconnection of TMS Equipment (Servers, Terminals, Video Wall Systems, Data Storage, Printers etc.) shall be fault tolerant.

(b) Networking Equipment used in Communication Network such as Bridges, Gateways, Routers, Switches and Repeaters shall have redundancy.

(c) The local area network employed shall be Dual LAN Network based on FDDI/Ethernet/Serial communication.

(d) Dual redundant link shall provide highly resilient communications network. System shall be tolerant to multiple simultaneous link failures, maintaining operation without degradation of performance. It shall be possible to perform maintenance on communication links without stopping the Signalling system.

(e) Data transfer to peripherals like printers & plotters can be at lower speed for each device using appropriate media with duplicate path.

(f) For connecting peripherals, screened twisted pair cables shall be used.

(g) The cables used shall be of rugged type with capability to work data up to at least 1000 Mbps.

(h) 30% spare Ports on Switches & Hubs etc. shall be kept spare for future use.

(i) Failure of any single Wayside Communication Equipment shall not cause failure of complete communication of TMS other than that of particular Wayside Communication Equipment.

(j) It shall be possible to interface and transfer the circuits on to the backup communication on redundant OFC, wherever available.

(k) All equipment shall be installed in standard 19” racks.

(l) The time slots working shall have redundancy. However, it shall be possible to transfer all data from one time slot to a redundant time slot, if required.

(m) The transmission with field station shall be controlled by polling wherever transmission is in serial mode and not in star configuration.

(n) In-built safety provisions shall be available to detect data corruption/ non-receipt of packets/node defect problems.

2.3.7 Video Wall Display System

(1) Video Wall Display

(a) The Video Wall Display shall be of rear projection screen (RPS) type based on single chip DLP Technology. It shall consist of RPS Display modules and Display Controller which will integrate various display modules into a single logical Display Wall.

(b) The Video Wall Display system shall be rugged and shall be able to work on 24x7 basis.

(c) The display windows shall be freely resizable, re-scalable and repositionable on any part of the display wall.

(d) Sufficient space shall be made available between the track indications for alphanumeric displays.

(e) Suitable Interface equipment and drivers for linking Indication panel with applications server shall be provided.

(f) The terminal server /driver for driving the Video Wall Display Panel shall have full-fledged capacity to drive described displays from provided equipment + 20% spare.

(g) The placement of Video Wall Display Panels, seating arrangement of the Controller's, viewing angle in vertical and horizontal plane etc. inside OCC shall be carefully planned. To ensure a user-friendly environment, an ergonomic study shall be performed by the Contractor to guarantee uniformity and consistency.

(h) Legibility, lighting, contrast, content, font size, viewing distance etc. shall be kept in view while designing graphics for the display.

(i) Surface shall have matt finish to keep it glare free.

(j) Glass backing shall be used so that there is no screen build bulge in.

(k) Station layouts can be arranged in a number of rows– top, middle and bottom.

(l) The lowest row shall not be below 1.5 meters (approx.) from the floor to ensure proper viewing angle. This shall be got agreed by the Engineer.

(m) Pedestal shall be made of Aluminium extruded and anodized members. Front of the pedestal shall be covered.

(n) It shall be compatible with the international VIDEO Standards.

(o) It shall have high MTBF and low MTTR. Values of the same shall be given with supporting calculations/data.

(p) Rear Projection System shall have rear service access.

(q) Projection system shall have cooling fan with dust filter.

(r) It shall be possible to increase/decrease the colour intensity, contrast adjusting etc. screen wise through the system console. It shall be possible to memorize the parameters of one screen and use the same parameters for all the other screens.

(s) The unit shall be compact and energy efficient so as to conserve on space and power consumption.

(t) The projector support software packages, documentation and details of maintenance shall also be supplied.

(u) Any other facility to make the system more user friendly shall be incorporated.

(v) Indigenous service support shall be available for the selected equipment in India.

(w) The Contractor shall design the Video Display wall of appropriate size to include all functionality required for EDFC-2 (Mughalsarai-New Bhaupur section).

(x) The Video wall system shall be generally similar in appearance to the other Video wall system planned/provided in EDFC Phase 1, so as to have uniformity with existing system. The Contractor shall interface with the contractor of EDFC Phase 1 for the same during design phase.

(y) The Contractor shall submit the colour scheme to be used for the symbols to be adopted for the Video Display Wall for approval by the Engineer. The Contractor shall also provide a mock-up of the display prior to the commencement of implementation for approval by the Engineer.

(2) Minimum Technical Requirements of Display Wall

Item	Specification
Projection Technology	Rear Projection based on Single Chip Digital Light Processing (DLP) technology
Architecture	The display unit/rear projection modules shall have in-built illumination system.
Display size	The diagonal size of each visual display unit/rear projection module shall be minimum 70 inches (Diagonal) - to be got agreed by the Engineer.
Resolution	Each individual cube minimum Full HD (1920x1080 pixels)
Aspect Ratio	16:10 or 16:9
Lamp type	LED – RGB
Display redundancy	The Display Unit/Rear Projection Modules should have in-built redundancy in LEDs for each colour and ensure redundancy at the light source level without any mechanical movement.
	Error shall also be shown by Diagnostic LED indicators in

Item	Specification
	case of LED lamp failure.
Cooling Mechanism	Cooling shall be by means of heat pipe. No pump based mechanism is acceptable due to possibility of failure.
Brightness	Shall be minimum 220cd/m² or higher.
Brightness Uniformity	≥ 95%. To automatically provide brightness and colour stability over time and across the entire display.
Contrast ratio (Full field)	≥ 1400:1
Colour gamut	Better than 100% EBU
Screen	Burn free. No memory and no ghosting. No constant flicker. Low reflection with matt finish.
Screen type	Fresnel/ Lenticular
Screen to screen gap	Shall be adjustable up to 1.0 mm or less for seamless viewing.
Viewing Angle	Full viewing angle shall be 180 degrees.
Pedestals	Shall be customized as per project requirements.
Component input Compatibility	480i, 480P, 720P, 1080i
Auto detection	System shall automatically search the source which has input signal after signal plug- in.
Source Redundancy	System shall be able to switch to secondary DVI input if primary DVI input is not available.
	System shall also automatically switch back to primary DVI from secondary DVI input as soon as primary DVI input becomes available again.
Power control	1AC power ON/OFF switch.
LED indicator	Power LED (Standby: Red, ON: Green, Fan led, Lamp LED).
IP /Remote Control	User should be able to control and monitor each Projection module through Internet / Intranet.
Component Life- LEDs	>60,000 Hours
LED Control	Dynamic control
Startup	Instant hot restart
Component life- DMD Panel	Shall be greater than 650,000 hours

(2) Display Controller

(a) The Display Controller shall be housed in an industrial 19" rack mounted casing (6U) based on Intel Quad Core CPU 2.66 GHz (Minimum)

(b) The Display controller shall have minimum memory of 4 GB.

(c) The Display controller unit shall be equipped with a DVD ROM Drive.

(d) The Display controller system shall be equipped with 500 GB HDD in RAID 1 Configuration.

(e) The Display controller shall be dual redundant with auto switchover including dual redundant hot swappable power supply.

(f) The Display controller shall have 10/100/1000 Mbps Redundant Ethernet port for LAN connection.

(g) The Display controller shall be supplied with a Keyboard and mouse with 20 m cable extension.

(h) The Display Controller shall be based on 64 bit Operating system.

(i) The Display controller shall have the possibility of connecting the various types of analog and digital sources which can be shown in freely scalable and moveable windows on the graphics wall. It shall support minimum 2 DVI/VGA/HDMI Inputs and 8 Composite video inputs.

(j) The hardware requirements described above are minimum requirements but are not definitive. The Contractor shall design and supply all hardware to fulfil all functionality, reliability and availability requirements as specified.

(3) Wall Management Software

(a) The Wall Management software shall provide control and management of application windows and display devices connected with the display controller.

(b) It shall be able to pre configure various display layouts and access them at any time with a simple mouse click.

(c) The software shall enable the users to see the desktop of the graphics display wall remotely on any Windows OS workstation connected with the Display Controller over the Ethernet and change the size and position of the various windows being shown.

(d) The software shall enable various operators to access the display wall from the local keyboard and mouse of their workstation connected with the Display Controller on the Ethernet.

(e) The software shall copy the screen content of the workstation connected on the Ethernet with the Display Controller to be shown on the Display wall in scalable and moveable windows in real time environment.

(f) The wall management software shall support open APIs to enable system integrators to integrate it with their Software.

(g) The Diagnostic software shall perform health monitoring that allows timely detection of faults.

(i) Wall health.

(ii) Cube health.

(iii) Cube IP-address.

(iv) Brightness.

(h) The software shall support control of brightness, contrast, saturation, hue, filtering, crop and rotate function on the various displays connected to the display controller.

(i) The integrated view shall provide a database that:

(i) Records all events.

(ii) Can record full status at given time intervals.

(iii) Can be exported to EXCEL/HTML; and

(iv) Show internal patterns.

2.3.8 Wayside Communication Equipment

(1) Wayside Communication equipment at Electronic Interlocking shall be provided with redundancy for meeting communication requirements between Wayside electronic Interlocking and Servers at OCC. It shall provide interface with the Potential Free Contacts of relays used in Signal Equipment Room.

(2) These units shall be installed in Signal Equipment room. 20% of the slots used for fixing I/O and peripheral cards shall be kept spare for future expansion.

2.3.9 Software Requirements

(1) The TMS software shall be developed conforming to the requirements specified in EN 50128 or other international equivalent standard for Safety Integrity Level 2 (SIL 2).

(2) The Software shall be designed, developed and tested according to the Software Quality Assurance Plan. The Contractor shall define within the Software Quality Assurance Plan what techniques and measures are applied for software development.

(3) All software shall be based on open system concept, shall be modular and independent of type of processor or hardware platform.

(4) The Software shall be developed on 64 bit UNIX/Windows/ or Multitasking Platform. All software shall be portable across similar operating systems.

(5) The TMS database shall be based on Relational Database Management System.

(6) It shall be possible to query the database either through format driven commands or by simple parameter related commands. These shall be formalised in consultation with the Engineer.

(7) The Contractor shall provide the procedures for maintenance of the security of the TMS system software along with application data considering sabotage, unauthorized Access, Virus etc. Suitable protection against Virus shall be provided.

2.3.10 Interface Requirements

(1) **Interface between TMS and SCADA system**

Interfacing with the OHE SCADA system shall be provided to achieve following information exchanges between TMS & SCADA:

(a) The RPS display screens, including display controllers, for SCADA system shall be provided by the Contractor. TMS shall interface with SCADA system to exchange any data between two systems. The contractor shall exchange and agree on the protocols and hardware/software interfaces between the systems. In case of conflict, the Engineer's decision shall be final.

(b) TMS will take OHE shut down reports from SCADA system.

(c) TMS will take details of the various power blocks granted and their duration from SCADA system.

(d) TMS will take details of OHE failures and tripping details of FP, SP, and SSP.

(e) SCADA will pick up failure of AT supply details from TMS.

(f) Any other information considered necessary by the Engineer.

(2) **Interface with Master Clock System**

(a) The system clock shall be synchronized with Master clock provided in OCC under PS (Telecommunications). The Contractor shall propose a suitable synchronization system in the event of failure of the Master Clock.

(3) **Interface with FOIS**

(a) TMS shall provide Train Identification along with train arrival and departure time for FOIS.

(4) **Interface with other TMS**

(a) The TMS provided under this contract shall be designed to interface with TMS provided for other sections of EDFC.

(b) It is a requirement that the train ID generated in one TMS system continues to be maintained or updated automatically with relevant information when the train moves into the adjacent section, provided with TMS of another vendor.

(c) Similarly, it is a requirement that the Signalling indications of one TMS section are exchanged with TMS of other sections when train crosses the boundary of the two sections.

(d) The contractor shall prepare Interface specification jointly with the contractors of other sections of EDFC detailing the information required to be shared between TMS provided by him and the TMS of other sections of EDFC. The contractor shall share all the required information of his TMS, including the data formats, protocols, physical/logical connectivity and limitations related to the interface, with the Employer/ other contractors, to enable them design their interface. Similarly, the contractor shall obtain all the required information from TMS providers of other sections of EDFC and design its interface accordingly.

(e) The Central Server provided under this contract shall interface with Central server (s) of APL1 contract for seamless exchange of information, including but not limited to the following:

(i) Train schedule information: Daily/seasonal Time table etc.

(ii) Train running information: Train identification, type, composition, crew details, dynamic location etc.
(iii) Train approaching the boundary of adjacent section.
(iv) Special events: Unusual delays, Loco fault, any unusual alarms etc.
(v) Any other information as required during the execution of the contract.

(f) The TMS of this contract shall normally use the Timetable and Crew Management system provided in EDFC Phase 1. To aid implementation, the contractor shall supply the necessary sectional data of EDFC Phase 2 to the contractor of EDFC Phase 1. Not only that the TMS provided under the contract be designed to receive the Timetable and Crew Management information from the Central server of TMS of EDFC Phase 1 but also it shall have facility to carry out any updates in the Timetable and Crew Management information provided in Central Server of EDFC Phase 1.

(g) The format of data exchange should be non-proprietary and vendor independent/open type such as XML, CSV, text strings etc. The protocol used for interface shall be industry standard open protocol, which shall be easily configurable such as Modbus TCP, Webserver etc. It shall be possible to establish/configure logical link between server/systems of adjacent TMS. The communication protocol used for TMS-TMS interface shall be TCP/IP based and data routing shall be possible by IP configuration.

(h) The interconnection with the neighbouring TMS shall be based on UIC or other equivalent standards.

(End of Chapter 2)*

CHAPTER 3: PERFORMANCE REQUIREMENTS

3.1 System Performance

3.1.1 The Signalling system shall be designed as per provisions of Employer's requirements, for a speed potential of 100 Kmph on the main line, keeping 10% safety margins.

3.1.2 The Contractor shall carry out to the satisfaction of the Engineer, the Simulation and other Performance tests to demonstrate the System Safety and Operational performance, including available 'Headway.'

3.1.3 The Reliability, Availability, Maintainability, Safety (RAMS) activities during the apportionment of system requirements, design and implementation, manufacture, integration, system validation, system acceptance and operation and maintenance during defect liability phases shall meet or exceed the requirements of CENELEC standards EN50126, EN50128 and EN50129 with latest amendments. The system phase related tasks to be carried out by the Contractor for these phases are highlighted as under:

3.2 Reliability, Availability, Maintainability (RAM)

3.2.1 The Signalling system shall achieve all RAM requirements specified in GS and this PS.

3.2.2 The Employer attaches great importance to the attainment of the highest possible reliability during service of all the equipment and systems supplied and installed under this contract. The design, manufacture, installation and commissioning of the equipment and also the training of the operating and maintenance staff shall be such as to ensure near Zero Failure performance in the initial stages and that the few defects and deficiencies that may be exposed during the Service Trial are totally eliminated.

3.2.3 All the sub-systems and equipment to be used for this system shall be of proven design, in use on other similar railway projects and reliability in accordance with RAMS standards.

3.2.4 The sub-systems and equipment shall be engineered to maximize system availability during traffic hours in accordance with RAMS standards, to minimize the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out in minimum time.

3.2.5 Fault Tolerance & Graceful Degradation: The system shall be designed such that service can be maintained in the presence of faults. Subsystems and components whose failure can significantly impact on RAM performance shall be backed up by simpler sub-systems or components that permit continuous operation.

3.2.6 Recovery: Provision shall be made to recover from any credible fault while minimizing disruption to service.

3.2.7 Condition Monitoring & Diagnostics: Diagnostic systems shall be used to detect, or where practicable, anticipate faults. Such systems shall be used to reduce requirements for preventive inspection and maintenance, to reduce overall costs, and improve reliability.

3.2.8 The Contractor shall submit system Reliability, Availability and Maintainability (RAM) Plan for review and approval of the Engineer.

3.3 Reliability Modelling

3.3.1 The Contractor shall perform Reliability and Maintainability analysis of each system, up to the point of interface with other systems.

3.3.2 The Contractor shall develop an evolving Reliability model consisting of Reliability Block Diagrams (RBD) and probability of success equations. This model shall show the relationships required for system and equipment to operate successfully. The RBD shall include multiple Electronic Interlocking and Track Vacancy Detection Systems that will be implemented for this project. The RBD shall also include all elements essential to the successful performance of the system and the interrelationships and interface of these elements. The model shall not reflect the degraded mode of operation. The Contractor shall revise the RBD model to keep current with design iterations.

3.3.3 The reliability model consisting of reliability block diagrams and probability of success equations shall be developed and submitted to the Engineer for acceptance.

3.3.4 Reliability apportionment and prediction analysis shall be in accordance with established techniques or standards, or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

3.3.5 The Reliability apportionment and prediction analysis shall be carried out in parallel with the design of the system. The relevant apportionment and prediction figures shall be part of the design submission documents for the individual equipment, sub-system and system.

3.4 Failure Definitions

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

3.4.2 Relevant Failure: A relevant failure of an item is an independent failure which results in a loss of function of that item caused by any of the following:

(a) A fault in an equipment or sub-system while operating within its design and environmental specification limits;

(b) Improper operation, maintenance, or testing of the item as a result of the Contractor supplied documentation.

(c) Failures of transient nature including those with post investigation status as 'No fault found', shall be considered as relevant failure if in the opinion of the Engineer these are attributable to Signalling System.

3.4.3 Non-relevant Failure: Any failure of an item not included in the definition of relevant failure, such as the following:

(a) A failure caused by malfunction of other equipment or sub-system that are not supplied by the Contractor.

(b) A failure caused by human error, except as noted in Relevant Failure above;

(c) A failure caused by accidents not associated with the normal operation of the item.

(d) A failure caused by operating the equipment or sub-system outside of design or environmental specification limits.

3.4.4 Service Failure: Any relevant failure or combination of relevant failures during revenue service operations to determine availability for revenue service, which results in one of the following:

(1) Delay to train service;

(2) Fault preventing a train from entering service at its scheduled time.

3.4.5 Pattern Failure: The repeated occurrences of 3 or more relevant failures of the same replaceable part, item or equipment in same manner in identical or equivalent applications when they occur at a rate which is inconsistent with the predicted failure rate of the part, item or equipment will be termed as pattern failure.

3.5 Reliability Requirements

3.5.1 Reliability requirements and goals shall be developed in terms of Mean Time Between Service Affecting Failures (MTBSAF)/Mean Time Between Failure (MTBF).

3.5.2 The reliability requirement is subsidiary to the Availability and Maintainability requirements as specified in this PS. If higher figures are required to achieve the Availability requirements then these higher figures shall become the reliability requirements for Signalling system.

3.5.3 The Signalling System shall be fault tolerant such that if failure of any sub-system is likely to adversely affect the train operation, the reliability shall be enhanced by providing redundancy in the system.

3.5.4 Redundant sub-system shall change over seamlessly when active system fails. If changeover has a finite time, contractor shall show that its system shall not obstruct the train operation.

3.5.5 The System shall be designed to generally recover from power supply disturbances without manual intervention. The failed axle counter track sections would require resetting as per Para 2.2.5 (2) (I) of this specification.

3.5.6 The Contractor shall minimize the risk of common mode faults in design of the subsystems providing redundancy.

3.5.7 The MTBF/MTBSAF of Interlocking, Track vacancy detection system, Power supply and other Signalling sub-systems shall be at least, as specified in the relevant RDSO specifications. Wherever failure of any sub-system/equipment is likely to adversely affect the train operation and Availability, the reliability shall be enhanced by providing redundancy in the system.

3.6 Availability

3.6.1 The Contractor shall be responsible for providing a system design, maintenance procedures, and defining the recommended spares holdings to ensure that the Availability requirements of the Signalling System are fully achieved.

3.6.2 The Contractor shall submit calculations with reliability block diagrams for each sub-system till LRU level to demonstrate the compliance with specified availability figures. The availability calculation shall take all possible failure modes (barring Non relevant failures, as per Para 3.4.3 above) into consideration that cause gap in service operation of system, subsystem, equipment or part thereof. The calculation shall be based on the Contractor's submitted equipment MTBSAF and MTTR data and the configuration of each sub-system.

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

3.6.4 Signalling System shall have Availability better than the targets specified here below:

System/Sub-System	Availability	Remarks
Electronic Interlocking System (including power supply, wiring, etc.)	99.98%	Availability per system

System/Sub-System	Availability	Remarks
Track Vacancy Detection System (MSDAC/SSDAC, power supply, etc.)	99.99%	Availability per system
Train Management System	99.98%	Availability per system

3.6.5 Degraded performance or loss of any software or hardware dependent function of any end equipment shall be taken as unavailability.

3.7 Perturbation Analysis

3.7.1 A detailed system perturbation analysis shall be performed stating the types of failures that could cause service interruptions and the failure management actions required to mitigate the effect of these failures.

3.7.2 The service interruption analysis shall document all failure modes capable of causing service interruptions.

3.7.3 The Contractor shall design the system to reduce the perturbations to the minimum. Operational actions, System design features or maintenance strategies that can reduce the impact of potential service interruptions shall be submitted to the Engineer for review.

3.8 Maintainability

3.8.1 Maintainability requirements and goals shall be developed in terms of Mean Time to Restore (MTTR). The required MTTR shall be achieved for the whole System.

3.8.2 The system shall be designed such that the MTTR shall be less than one hour.

3.8.3 The MTTR shall include the diagnostic time, active repair / replacement time and adjustment / testing time, including software re-boot, up to the point the system is restored to full functionality. In the event that the failure cannot be rectified, the measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functional module.

3.8.4 The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities or the time taken for the replacement parts to be delivered at site.

3.8.5 The Contractor shall analyze each and every failure/defect of components of various equipment to determine the cause of failure and to propose preventive/corrective measures in the FMECA analysis.

3.8.6 The System shall be suitably designed to minimize the need for frequent preventive maintenance.

3.8.7 Redundancy shall be used to enable any necessary preventative maintenance to be carried out on off-line systems during Traffic Hours.

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

3.8.9 As far as the technology permit, all vital plug-in modules shall permit hot swapping so as not to affect the normal or emergency operation of the system

3.8.10 The Contractor shall provide Service Life support as specified at Para 14.11 of the GS Vol. 1 Part 2 Section VI.

3.9 Line Replacement Unit (LRU)

3.9.1 All line replaceable units shall have weight that can be easily handled manually without posing any significant risk. The System shall allow the removal and reinstallation of LRUs without having to remove other LRUs, disconnect cables to other LRUs or disturb or power down other equipment.

3.9.2 Incorrect installation or incorrect attachment of any LRU to be prevented through mechanical design.

3.9.3 The System shall be designed to ensure that any components which are physically interchangeable but not functionally interchangeable cannot operate in the System.

3.9.4 LRU electrical connections shall be formed by using plugin units as far as practicable.

3.9.5 The System shall be designed such that Electronic racks are removable. The System shall be designed such that access panels can be removed without the use of special tools.

3.9.6 The System shall maximize the use of remote means to conduct maintenance, fault finding and fault rectification activities and to access maintenance information.

3.9.7 The Signalling System shall display all detected failures on the S&D terminal at the Station and in the OCC.

3.9.8 Fault indications should clearly indicate which LRU is affected and the degree of the failure and loss of functionality.

3.9.9 Where the System architecture is such that Signalling control systems are distributed across the section and where all maintenance testing and diagnostics cannot be conducted entirely remotely from the OCC, the local Control and Indication means shall be provided at these locations for maintenance purposes.

3.10 Safety Engineering

Safety is defined as freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property, or withdraw the train from service. All circumstances susceptible to cause injuries or death of a person (public, operation staff, maintenance staff), and by extension all events leading to a partial or total destruction of costly equipment are considered as a risk.

3.11 System Safety Plan

The Contractor shall develop System Safety Plan in accordance with EN 50126 and submit the same for review and approval of the Engineer.

3.11.1 Safety Principle

(1) All equipment and sub-systems, including software, affecting safety and identified as being "vital", shall be designed according to the following principles:

(a) Only components having a high reliability and predictable failure mode shall be used.

(b) Components must be utilized in such a manner that ensures that a restrictive, rather than a permissive condition will result from hardware, software or any part of the equipment failure.

(c) Circuits shall be designed such that when a normally energized electric circuit is interrupted or de-energized, it will cause the controlled function to assume its most restrictive condition.

(d) System safety equipment design shall be such that any single independent component or subsystem failure results in a restrictive condition. Failures

that are not independent, those failures which, in turn, always cause others, must be considered in combination as a single failure and must not cause a permissive condition.

(2) The Signalling system shall fully conform to the interlocking principles as specified in the Indian Railway Signal Engineering Manual.

(3) During consideration of precedence in the control of system hazards, the Contractor shall take actions to satisfy requirements in the following order of precedence:

(a) Incorporation of fail-safe on vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and,

(b) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

3.11.2 Safety Requirements

(1) The Contractor shall be fully responsible for the system safety within his domain through the application of engineering and management principles, criteria and techniques to optimize all aspects of safety throughout all phases of the System life cycle.

(2) The safety level of Electronic Interlocking (EI) and Track Vacancy Detection Systems realized with software shall satisfy the SIL4 or equivalent safety level. The software design process of TMS shall conform to SIL 2 level.

(3) Component failure shall be self-detecting by way of causing a signal to display a most restrictive aspect as far as practicable. Failure of components which are not self-detecting shall not cause any unsafe failure of the equipment.

(4) The design of the equipment shall cater for detection and restoration of system to a safer state in case of following faults if these are likely to result in unsafe condition:

(a) Variation in power supply beyond its tolerance limits.

(b) Spikes in the power supply system.

(c) Insertion of PCBs in wrong card slots.

(d) Earthing of any component or wire or a combination of such earthing faults.

(e) Broken wires, damaged or dirty contacts, failure of a component to energize, loss of power supply or blown fuses etc.

(5) During each stage in the design and development process, the Contractor shall take cognizance of any hazard that arise as a result of the design or operation of the proposed equipment and take immediate steps to change the design or operation principals of the proposed equipment to mitigate the hazard.

(6) Occurrence of any failure or error of operation in the axle counter components must not lead to any hazard but should rather transit to a safe state.

(7) The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensure that the safety device does not introduce an additional hazard or system malfunction.

(8) The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder. The Contractor shall recommend special equipment operating procedures to reduce the probability of a

hazardous event.

(9) A Hazard Log shall be established as a basis for on-going risk management. The hazard Log shall be updated with each event identified and mitigated. Residual Risk shall be carried forward and rules and procedures proposed to the Engineer for the Management of such Residual Risk.

(10) During the Design Review process, the Contractor shall submit analysis for Engineer's review, which demonstrate compliance with these safety principles. These analyses shall address the following issues:

(a) Circuit design;

(b) Hardware design (Failure Modes, Effect and Criticality Analysis);

(c) Electrical interference;

(d) Software errors; and

(e) System failures.

(11) All metallic enclosures shall be provided with an earth terminal.

(12) The design of the System shall minimize the risk of fire.

(13) The design of the System shall minimize the build-up of static, as well as the effects of static discharge during maintenance.

(14) Components or materials containing toxic chemicals or asbestos should not be used unless absolutely necessary and where they are to be used, they should be submitted to the Engineer for agreement.

(15) The safety level of each function outlined in this specification shall be defined and demonstrated by the Contractor in accordance with the process defined in General Specifications.

3.11.3 Risk Acceptance Criteria

(1) Risk is defined as probable rate of occurrence of a hazard causing harm and the degree of severity of the harm. Risk acceptance shall be based on the principle of "As Low as Reasonably Practicable" (ALARP) based on the guidelines set out in EN 50126.

(2) The frequency of occurrence of hazardous event is categorized into different rankings:

Category	Description
Frequent	Likely to occur frequently. The hazard will be continually experienced.
Probable	Will occur several times. The hazard can be expected to occur often.
Occasional	Likely to occur several times. The hazard can be expected to occur several times.
Remote	Like to occur sometime in the system life cycle. The hazard can be reasonably expected to occur.
Improbable	Unlikely to occur but possible. It can be assumed that the hazard may exceptionally occur.
Incredible	Extremely unlikely to occur. It can be assumed that the hazard may not occur.

(3) The hazard severity is categorized into different hazard consequence levels:

Hazard Category	Consequence	Description
4	Catastrophic	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.
3	Critical	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.
2	Marginal	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage. Acceptable with adequate control and agreement of the Employer.
1	Negligible	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

(4) Risk classification of hazards:

Frequency		Consequence			
		Catastrophic (Category 4)	Critical (Category3)	Marginal (Category2)	Negligible (Category1)
Frequency	Frequent	I	I	I	II
	Probable	I	I	II	III
	Occasional	I	II	III	III
	Remote	II	III	III	IV
	Improbable	III	III	IV	IV
	Incredible	IV	IV	IV	IV

(5) The Risk Classes are defined as follows:

Risk Class		Interpretation
Class I	Intolerable	Intolerable risk. Shall be eliminated
Class II	Undesirable	Undesirable risk, and tolerable only if risk reduction is impracticable of if the costs are grossly disproportionate to the improvement gained. Shall only be accepted when risk reduction is impracticable and with the agreement of the Railway Authority or the Safety Regulatory Authority, as appropriate

Risk Class		Interpretation
Class III	Tolerable	Tolerable risk if the cost of risk reduction would exceed the improvement gained. Acceptable with adequate control and with the agreement of the Railway Authority.
Class IV	Negligible	Negligible Risk. Acceptable with/without the agreement of the Railway Authority

(6) Risk acceptance shall be based on the principles of "As Low as Reasonably Practicable" (ALARP) and as follows:

(a) Category 4 hazards shall be not greater than one unsafe incident in one hundred years (1:100 years).

(b) Category 3 hazards shall not be greater than one unsafe incident in one hundred years or only be accepted when the risk reduction is impractical and with the agreement of the Employer.

(c) Category 2 hazards shall only be permitted if a desired benefit is demonstrated as generally acceptable within accepted levels for the international railway industry and in agreement with the Employer.

(d) Category 1 hazards shall only be permitted if assured that the risk will remain at that level and any residual risk shall be mitigated by Operating Rules and Procedures

3.11.4 Hazard Analysis

(1) The Contractor shall, as part of the safety analysis, prepare analysis to identify Hazards and ensure their satisfactory resolution. The following analysis shall be prepared and submitted by the Contractor for the Engineer's acceptance:

(a) Preliminary Hazard Analysis (PHA)

(b) Subsystem Hazard Analysis (SSHA)

(c) Interface Hazard Analysis (IHA)

(d) Operating and Support Hazard Analysis (O&SHA)

(e) Quantitative Fault Tree Analysis (QFTA)

(f) Failure Modes, Effects and Criticality Analysis (FMECA)

(2) The Contractor shall carryout the Hazard Analysis and FMECA/FTA for key equipment / sub-systems / systems. As a result of hazard analysis, the Contractor shall:

(a) Identify and list the hazards

(b) Identify and list the Safety Requirement Specifications

(c) Identify and list the safety related functions

(d) Specify for each safety related function the safety related failures

(e) Identify and list the safety critical and non-safety critical items.

(3) The Hazard Review Procedure shall be submitted for the Engineer's approval. The

final risk assessment, acceptance of mitigation and close out of hazards shall conform to the approved safety and risk acceptance criteria.

(4) The following targets/norms shall be employed for the Fault Tree Analysis. These norms are subject to review by the Engineer during the detailed design stage, and mutually agreed upon:

(a) No single point failure shall lead to fatality.

(b) No combination of undetected failure and double point failures shall result in fatality.

(c) No combination of undetected failure and single point failure shall result in major injury.

(5) The Hazard Log shall be substantially complete prior to commencement of Trial Running and shall be handed over to the Employer complete in all respects prior to the commencement of Revenue Service.

(6) The Contractor shall fully develop a Safety Critical Items List (SCIL) which shall be updated as required and carried forward throughout implementation until final resolution of identified hazards is achieved.

(7) Further, the information presented by the Contractor shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the engineering program characteristics and behaviour.

(8) The procedures for Operation, Maintenance, Training and the Contractor Quality Assurance manuals shall incorporate resolution of hazards so identified from this Hazard Analysis. Proper cross-referencing to the hazards and resolution measures shall be provided in all these aforementioned documents.

3.11.5 Design/Systems Safety Studies and Report

(1) The Hazard analysis process shall identify the need for Design Safety Studies and the Hazard Log shall record the results of each of these Design Safety Studies.

(2) Design Safety Studies shall be undertaken for system and subsystem elements that are considered to be safety critical and that require hazard analysis to a greater level of detail than that applied at an overall system wide level.

(3) Design Safety Studies shall specifically refer to hazards arising from:

(a) normal operations including maintenance;

(b) degraded modes of operation;

(c) emergency situations; and

(d) the effectiveness of mitigation proposed for natural catastrophes.

(4) The Design Safety Studies shall take account of:

(a) methods of operation;

(b) RAM considerations;

(c) anticipated likely maintenance regimes and their sustainability in Commercial Operation;

(d) anticipated competence levels of personnel in Commercial Operation;

(e) software security (disabling of unauthorized access to operating systems, protection against intrusive attacks, loss of password integrity, etc.); and

(f) Other human factors including but not limited to those identified in ergonomic studies.

(5) Design/Systems Safety Studies and the Report shall demonstrate, as a minimum, the following requirements:-

(a) That the overall risk criteria for the Works have been addressed satisfactorily at the Detailed Design stage and that the Detailed Design proposals are mutually compatible with such risk criteria.

(b) That all Safety Critical systems have been identified at the Detailed Design stage and the apportionment of risk factors between the major systems and sub-systems support the overall safety criteria approved in the "System Safety Plan".

(c) That the results of the Design Safety Studies have been incorporated into the design, and shall be carried forward into the Final Design, manufacturing and installation processes.

(d) That where management by operating and/or maintenance procedure or other management control measures have been identified during the "Design Safety Studies", auditable methods by which such measures shall be introduced into operating/maintenance provisions have been established.

(e) That robust processes have been implemented to validate the Safety Critical aspects of software design.

(f) That processes for assessing the potential safety impact of design changes exist.

(6) The Design/Systems Safety Studies and a Report shall be submitted at the completion of the Detailed Design period to confirm that all safety related aspects of design have been properly addressed and comprehensively validated.

3.11.6 Engineering Safety Validation Plan and Report

(1) The contractor shall submit Engineering Safety Validation Plan that will outline the safety related tests to be conducted during the on-site testing and integrated system testing phase. The document will include the validation of the safety requirements for the system such as output voltage of DC-DC converter or an inverter shall not exceed pre-set value. Throughout this document details test cases carried out in order to validate the system, the relationship of the effects found in these tests and the validation of the same in subsequent tests will ensure that the system comply with the safety requirements.

(2) An Engineering Safety Validation Report will be submitted after the completion of this testing.

3.11.7 Safety Case

The contractor shall submit the Safety Case which will be a documented demonstration that the product complies with the specified safety requirements. The Contractor may be required to issue updated Safety Case conforming to EN50129 after Trial Run. The Safety Case forms part of the overall documentary evidence to be submitted to the relevant safety authority in order to obtain safety approval for the system.

3.11.8 Independent Safety Assessor

(1) The Employer will appoint an Independent Safety Assessor (ISA) for safety assessment of the Signalling system, including Signalling equipment (if required) to be provided by the Contractor.

(2) The ISA will audit the Signalling system at all stages – design, supply, installation and commissioning, to check compliance of the (to be implemented) Signalling system with Safety requirements specified in the Bid document, and suggest corrective actions.

(3) The Safety assessment of the Signalling equipment – EI and DAC, may also be carried out by the ISA as per 'Cross acceptance/approval policy' at Appendix 3.

(4) The Contractor/manufacturer shall ensure that ISA is provided with full assistance in performance of his duties. The Contractor/manufacturer shall provide ISA with all documents, as requisitioned by him from time to time. The Contractor/manufacturer shall also conduct Tests and Trials, as per requirement of ISA. The Contractor/manufacturer shall carry out the corrective actions suggested by the ISA from time to time.

(5) All the costs associated with providing documentation, Tests and Trails or carrying out any corrective actions suggested by the ISA shall be borne by the Contractor/manufacturer.

3.11.9 Relational Database Management System

(1) All hazard resolution by procedural control shall be cross-referenced from the safety critical and non-safety critical Items List to the appropriate manuals. The results of the Hazard Analysis shall be recorded and maintained by the Contractor in a Hazard Log in the form of a relational database that can be used to track progress in the implementation of mitigating actions and control measures, and provide an easily accessible reference for the future Operator of all actions taken with respect to any hazard of any type in an any location for any area of activity. Proper cross-referencing to the hazards and resolution measures shall be provided in all these afore mentioned documents.

(2) The fully functional soft copy of the relational database management system shall include together with all passwords, supporting software and instructions on its use and further development during Revenue Service.

3.12 RAM Demonstration

3.12.1 RAM Demonstration Plan

(1) The Contractor shall submit RAM Demonstration Plan to the Engineer for approval before the final design review to demonstrate that all RAM predictions and specifications are met.

(2) The requirements relating to Maintainability shall be demonstrated before the commencement of Trial Running and may begin as soon as the necessary systems or elements of systems have been tested and commissioned.

(3) The requirements relating to Reliability and Availability shall be demonstrated throughout Trial Running Period and the Defects Liability Period.

3.12.2 Failure Reporting and Corrective Action System (FRACAS)

(1) The Contractor shall be required to establish a computer based Failure Reporting and Corrective Action System (FRACAS) during the RAM Demonstration phase. The FRACAS proposed by the contractor shall need the approval of the Engineer.

(2) The FRACAS shall:

(a) Provide a process for reporting, classifying, analysing failures, and planning corrective actions in response to those failures.

(b) Collect data, record and analyse system failures.

(c) Produce a history of failure and corrective actions.

3.12.3 Reliability Demonstration

(1) During the RAM demonstration phase, the Contractor shall collect and maintain data on every failure of the system provided by him along with the data indicating the probable failure. MTBSAF shall be calculated throughout the monitoring period. The Contractor shall submit monthly Reliability Demonstration Reports.

(2) In case the Contractor is not able to achieve specified/predicted reliability target, the Contractor shall take necessary corrective measures either by way of change of design and/or replacement of the relevant equipment / component, at no additional cost to the Employer.

(3) The Contractor shall analyze each and every failure/ defect of components of various equipment to determine the cause of failure and propose corrective measures, which would be reviewed by the Engineer.

3.12.4 Maintainability Demonstration

(1) The Contractor shall carry out tests on all the system provided by him to demonstrate that all maintainability predictions provided are met.

(2) The maintainability demonstration shall consist of simulated failures and repair activities, the duration of which shall be measured to determine the MTTR. As an alternative, data from actual maintenance actions for relevant independent failures occurring during the testing period may be used in lieu of simulation.

(3) A minimum of 50 maintenance actions shall be included for this demonstration.

(4) The maintenance actions shall be distributed among the equipment of each test group in proportion to their expected failure occurrence and in accordance with the MTBSAF.

(5) In the event that any maintainability target is not achieved, the Contractor shall at his own expense take whatever action is deemed necessary to meet the maintainability targets.

(6) The Contractor shall ensure that all the required information including the related Maintenance Work Instructions (MWI) etc. are available to enable him to demonstrate the maintainability targets.

3.12.5 Availability Demonstration

(1) The Contractor shall demonstrate the specified Availability during Service Trials and during the DLP. The Availability Demonstration Testing (ADT) shall be conducted on all Systems, subsystems and their interfaces.

(2) The demonstration test measure for Availability shall consider the performance of the Contractor's installed equipment, and the effectiveness of maintenance procedures recommended by the Contractor.

(3) The availability shall be worked out on the basis of the formula given during the preceding six months. In the event that the availability target as specified is not achieved, the Contractor shall,

(a) The determination of availability achievement in the preceding six month period shall be continued at monthly intervals until the target is achieved.

(b) The contractor at his own expense, will take action deemed necessary to meet the availability requirement.

3.13 Environment

3.13.1 Details of climatic conditions generally prevalent in Mughalsarai-New Bhaupur section are given in Para 2.5 of GS Vol.1 Part 2 Section VI.

3.13.2 The Signalling Equipment rooms in OCC and at the stations will be built and provided with air-conditioning by 'Other contractors' and will have following Environment classifications:

(1) Signalling Equipment Room(s) in OCC: Class A

(2) Signalling Equipment Room(s) at Station: Class B1

3.13.3 The Signalling Equipment Rooms and Signalling Power Supply Equipment Rooms in the Block section to be built by the contractor, and Signalling Power supply Equipment rooms at the Stations, being built by 'Other contractors' shall normally have following Environment classifications:

(1) Signalling Equipment Rooms in Block section: Class B2

(2) Power Supply Equipment Rooms at Stations and in Block sections: Class B2

The contractor shall provide in the above rooms, suitable ventilation system with redundancy (1+1) to regulate temperature and maintain air circulation within limits. The contractor may, however provide Air-conditioning of these rooms/equipment racks, wherever necessary for environment control or for improvement of reliability of specific Signalling equipment or its power supply.

3.14 EMC/EMI Requirements

3.14.1 The Signalling system provided should be electromagnetically compatible with other systems viz. Electrification, Telecommunication and Rolling Stock as per relevant national and international standards specified at Para 4.1.2 of this specification.

3.14.2 The Contractor shall conduct the EMI Hazard analysis at the preliminary design stage to identify sources of EMI likely to affect the Signalling system, its consequences and EMC protective measures, all of which should be detailed in the EMI Hazard analysis report. The EMI Hazard analysis report shall be submitted to the Engineer for review and acceptance.

3.14.3 EMC Control Plan

(1) The contractor shall prepare an EMC control plan and submit it to Engineer for review and acceptance.

(2) The plan shall analyse EMI/EMC impacts on the design of the Signalling System including trackside equipment as well as the general environment.

(3) The Plan shall specify measures to increase immunity of the Signalling system.

(4) The Plan shall include measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by the relevant national and international standards.

(5) The plan shall specify basic protective measures proposed for all electrical and electronic subsystems and components and specific measures to be adopted for the selected subsystems and components.

3.14.4 Intra system EMI

The Contractor shall ensure that any intra system EMI is mitigated through proper design and other special measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipment operating in Railway or similar industrial environment as listed under Para 4.1.2 of this specification

3.14.5 Inter system EMI

(1) The Contractor shall ensure that all the Signalling System is designed and manufactured in accordance with the latest issues or versions of internationally recognized EMC standards, including but not limited to EN50081, EN50082, EN50121, EN50123, IEC571, EN50155, and IEC61000 to ensure proper functioning.

(2) The contractor shall identify all likely sources of EMI that are prevalent in the environment. Adequate measures may be taken to ensure correct operation of the Signalling system in its intended operating environment.

3.14.6 EMC Tests

(1) The contractor shall not be required to conduct EMC tests if it can be demonstrated that the same have been done at the design stage of his equipment. However, if EMC tests were not done or if no test reports are submitted, the tests have to be conducted in accordance with, but not limited to satisfying following standards for overall compliance:

(a) EN50121-1

(b) EN50121-2

(c) EN50121-4

(d) EN50121-5

(2) In all cases where tests are not conducted, waiver for the same may be applied along with justification for approval of the Engineer.

(3) For any standard off-the-shelf products, their EMC test certificates shall be submitted to the Engineer for review.

3.14.7 Safety related Systems Interference (Hardware/Software interfaces & protocols)

(1) Special attention shall be given to the interference with safety related operations and equipment such as communication systems. Adequate safety margins must be ensured between the immunity levels of these safety related systems and emission levels of the Signalling and Control System specified by prevailing international standards.

(2) If considered necessary, following measures shall be taken to improve the

immunity of the Signalling system. These measures shall include, but not limited to the following actions:

(a) Proper grounding to reduce ground-loop coupling.

(b) Proper cable shielding to reduce common-mode coupling.

(c) Proper use of twisted-pair cable to reduce differential mode coupling.

(d) Proper magnetic shield to reduce low-frequency magnetic field interference from the traction system.

(e) Use steel cable supports (trunkings, trays, etc.) instead of aluminium.

(f) All cable supports shall be grounded.

(g) Correct choice of operating frequency.

(h) Use of filter to reject out-of-band noise.

(i) Proper use of surge arrestor.

(j) Use of high-level modulation technique to improve the immunity of the system.

(k) Use of redundancy codes/check sum etc. to improve the immunity of the system.

(l) Use of parallel-check technique to improve the immunity of the Signalling system.

(m) The probabilities of various conditions which could lead to an unsafe operation shall be determined and action to resolve the same shall be taken.

(n) An appropriate technical construction file suitable for safety audit shall be submitted or if not available developed to demonstrate EMC compliance.

3.14.8 Installation mitigation guidelines for Cabling

(1) The cables used in the Signalling system shall be adequately protected against external interference.

(2) Additional protective measures, including but not limited to the use of metallic conduit, armour, ferrite choke and EMI filters shall be used to reduce such external interference wherever required. Covered conduit is preferred.

(3) The cables shall also be installed at a safe separation from potential interfering sources, including power cables etc.

(4) A cable routing plan shall be designed so that there is least likelihood of coupling between the Signalling cables and the extraneous potential sources. For example, long parallel run of Signalling cable and power cable shall be avoided unless they are enclosed within separate conduits/covered troughs.

(5) The Contractor should refer to guidelines recommended by IEC61000-5-2, wherever possible for signal trunking /conduit separation.

(6) For protection against electrostatic capacitance coupling, direct electrical connection between ducts of power cables and signal cables shall be avoided.

3.14.9 The latest versions of IEC61000-5 and other relevant standards shall be complied with wherever applicable.

(End of Chapter 3)

CHAPTER 4: GENERAL REQUIREMENTS

4.1 Project Design Standards

4.1.1 High Level Standards

(1) The project requires contractors to work within the framework of the international standard for Quality Management ISO 9000.

(2) Working within IEC61508, Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related System, the suppliers/contractor should demonstrate how compliance will be achieved for this project.

(3) Where systems and products have been designed and are approved against Design standards as specified at Para 4.1.2 below, full details of approval shall be given. Where systems and products have been approved within other markets, for example against US FRA standards, then a gap analysis between the design and approving standard and the appropriate design standard specified at Para 4.1.2 below shall be required before products are approved for use on the project. The contractor will be required to give detail of how the gap analysis will be conducted.

4.1.2 Design Standards

(1) The generic standards or other equivalent standards which are specified as under shall be applied for Signalling system.

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

(b) IEC: International Electro-technical Commission.

(c) EN: European Standards Organizations CEN, CENELEC or ETSI.

(d) ISO: International Standards Organization

(2) Research Design and Standards Organization (RDSO), an organization of the Ministry of Railways, Government of India has standardized the technical specifications for various components of railway systems in India as Indian Railway Standard (IRS) Specifications. These are generally based on International Specifications and adopted to Indian conditions. The list of IRS/RDSO Specifications issued by RDSO is available at the website of RDSO (www.rdso.gov.in). The IRS/RDSO specifications can be purchased from RDSO.

(3) For the Signalling system, the following specified standards (with latest amendments) shall be followed:

SPECIFICATION NO.	DESCRIPTION
IRS SPECIFICATIONS	
S 6-81	Tubular Steel Signal Poles
S 23 - 88	Electrical and Electronic based Signalling and inter-locking equipment. Part 1: Technology & General requirements. Part 2: General requirements for Electrical Signalling & inter-locking equipment.
S 24 - 2002	Non-trailable electric point machine
S 26 - 64	Colour light signal, multi-unit type

SPECIFICATION NO.	DESCRIPTION
S 34 - 68	Testing Railway Signalling relays (General)
S 36 - 87	Route Relay interlocking systems
S 42 - 85	Axle counting equipment
S 43 - 73	Automatic signalling for unidirectional traffic
S 63 - 2007	PVC insulated underground unscreened cables for Railway Signalling
S 66 - 84	Route indicator, direction type 5 lamp unit arm (1 to 6 way)
S71 - 87	Tag block
S 76 -89	PVC insulated indoor cables for Railway Signalling
S 93 - 96	Valve Regulated Lead Acid Stationary Battery & Charger for Railway S&T Installations
S 101 - 90	Railway Signalling symbols
S 105/2012	Block Proving by Axle Counter using UFSBI
TC-30/2005	Four / Six Quad Underground Jelly Filled Cables
TC-55-2006	24 Fibre Optic Fibre armoured cable
RDSO SPECIFICATIONS	
RDSO/SPN/144/2006	Safety & Reliability requirement of Electronic Signalling Equipment
RDSO/SPN/153/2011	LED Signal lighting unit
RDSO/SPN/165/2012	Integrated Power supply system (IPS)
RDSO/SPN/175/2005	Solid State Block Proving by Axle Counter (Digital)
RDSO/SPN/176/2005	Multi Section Digital Axle Counter
RDSO/SPN/177/2003	Single Section Digital Axle Counter
RDSO/SPN/188/2004	Block proving with Axle counter
RDSO/SPN/189/2004	Terminal Blocks, Fuse terminal blocks and Miniature fuse links of international standard for Railway Signalling
RDSO/SPN/192/2005	Electronic interlocking
RDSO/SPN/197/2008	Code Practice for Earthing and Bonding system for Signalling equipment
RDSO/SPN/203/2011	Electronic Interlocking for Big Yards

SPECIFICATION NO.	DESCRIPTION
RDSO/SPN/204/2011	Double Walled Corrugated HDPE ducts for signalling cables
RDSO/SPN/208/2012	Electric Lifting Barrier
STS/E/Relays/AC Lit LED Signal/09	Universal Plug-in type, tractive armature AC Lamp proving relay (metal to carbon) for 110V AC LED Signal Lamp
EUROPEAN STANDARDS	
EN 50121 1,2,3,4	Railway applications - Electromagnetic compatibility
EN 50124 - 1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electronic equipment
EN 50124 - 2	Railway applications - Insulation coordination - Part 2: Over-voltages and related protection
EN 50125 - 3	Railway applications - Environmental conditions for equipment - Part 3: Equipment for signalling and communications
EN 50126	Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
EN 50128	Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems
EN 50129	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for Signalling
EN 50159 - 1	Railway applications - Communication, signalling and processing systems - Part 1: Safety related Communication in closed transmission systems
EN 50159 - 2	Railway applications - Communication, signalling and processing systems - Part 1: Safety related Communication in open transmission systems.
EN 60529	Specification for degrees of protection provided by enclosures (IP Code)
EN 50081 - 2	Electromagnetic compatibility - Generic Emission Standards - Part 2: Industrial Environment
EN 50123	Railway Application-Fixed installations .D.C. Switchgear. General
EN 50082 - 2	Electromagnetic compatibility. Generic immunity standard. Industrial environment.
EN 60364	Lightning and Surge protection
EN 61643	Lightning and Surge protection

SPECIFICATION NO.	DESCRIPTION
EN 62305	Lightning and Surge protection
EN 60204 - 1	Safety of machinery. Electrical equipment of machines. General requirements
IEC 61000.4.2	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test and basic EMC
IEC 61000.4.4	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic fast transient/burst immunity test and basic EMC publication
IEC 61000.4.5	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Surge and immunity test
IEC 62278	Railway Applications- Specifications and demonstration of Reliability, Availability, Maintainability & Safety.
IEC 62279	Railway Applications-Communications, Signalling and processing systems-software for Railway Control and Protection Systems.
IEC 62425	Railway Applications-Communications, Signalling and processing systems- Safety Related Electronics Systems for Signalling.
IEC 62427	Railway Applications- Compatibility between Rolling Stock and Train Detection Systems
IEC 62280-1	Railway Applications-Communications, Signalling and processing systems – Safety related communication in closed transmission systems.
IEC 62280-2	Railway Applications-Communications, Signalling and processing systems - Safety related communication in open transmission systems.
IEC 62236	Railway Applications – Electromagnetic compatibility (EMC)
IEC 60571	Electronic Equipment Used on Rail Vehicles
IEC 61373	Railway Applications – Rolling stock equipment – Shock and vibration tests
IEC 62305	Protection against Lightning
IEC 61992	Railway applications – Surge arresters and low-voltage limiters for specific use in. D.C. systems
IEC 60364	Electrical Installations for Buildings
IEC 62505	Railway applications – Fixed installations – Particular requirements for A.C. switchgear
ISO/TR 16982:2002	Ergonomics of human-system interaction -- Usability methods supporting human-centred design

SPECIFICATION NO.	DESCRIPTION
ISO 11064 Parts 1-7	Ergonomics Design of Control Centres

4.1.3 Following manuals and schedules shall also be referenced during the design:

(1) Indian Railways Signal Engineering Manual (IRSEM).

(2) General Rules (GR) of DFCCIL/IR.

(3) AC Traction Manual (ACTM) of IR.

(4) Indian Railways Permanent Way Manual (IRPWM).

(5) Schedule of Dimensions (SOD) of Eastern Corridor of DFCCIL.

4.1.4 Following Indicative Typical arrangement drawings shall also be referenced during the design:

(1) Single line diagram for 1-phase input & 1-phase output UPS system (Annexure I of Appendix 2)

(2) Single line diagram for 3-phase input & 3-phase output UPS system (Annexure II of Appendix 2)

(3) DFCC Cable Laying in Station Yard (Annexure II (a) of Appendix 4)

(4) DFCC Cable Laying in Block section (Annexure II (b) of Appendix 4)

(5) Cable trench (Annexure III of Appendix 4)

(6) Laying of cables in rocky area (Annexure IV of Appendix 4)

(7) Track crossing (Annexure V of Appendix 4)

(8) Road crossing (Annexure VI of Appendix 4)

(9) Cable laying on culverts with low flood level (Annexure VII of Appendix 4)

(10) Cable laying on culverts with high flood level (Annexure VIII of Appendix 4)

(11) Cable laying on metallic bridges (Annexure IX of Appendix 4)

(12) Cable Trough for metallic bridges (Annexure X of Appendix 4)

(13) Typical Scheme of Track vacancy detection system using MSDAC in Automatic Block section.(Appendix 5)

(14) Typical Earthing and Bonding arrangement for Indoor Signalling equipment. (Annexure I of Appendix 6).

(15) Typical Earthing, Bonding and Surge Protection arrangement for Location box having Electronic equipment. (Annexure II of Appendix 6).

(16) Signalling System Architecture (Appendix 7)

4.2 Procurement

4.2.1 The contractor can procure items/equipment either locally (from India) or from the international market.

4.2.2 RDSO maintains an approved list of suppliers/vendors for various equipment/items/ components to be used on railway systems in India. The list of suppliers/vendors approved for various items are available at the website of RDSO (www.rdso.gov.in). The list of applicable RDSO specifications is given in Para 4.1.2 of this Specification.

4.2.3 Equipment appearing in this list of applicable RDSO specifications at Para 4.1.2 and having RDSO approved vendor, if procured locally shall be from RDSO's "Approved list of firms for manufacture and supply" and as per relevant specification.

4.2.4 If any equipment appearing in this list of applicable RDSO specifications at Para 4.1.2 is imported, then the firm supplying the equipment shall be got approved from RDSO for manufacture and supply of the said equipment as per latest "Procedure Order for Cross Acceptance/Approval of Software Embedded Electronics Systems and New/Imported Technology Products for Railway Signalling", presently dealt under Para 4.3 of RDSO's Document No: SI-WI-7.1-3 I dated 01.09.2011 on Work instructions for Vendor approval of signalling developmental items" available at Signal Directorate, RDSO's website www.rdso.indianrailways.gov.in. However, in respect of Electronic Interlocking and Digital Axle Counters the said Cross acceptance/ approval can also be obtained as per "Procedure Order for Cross Acceptance/Approval of Software Embedded Electronics Systems and New/Imported Technology Products for DFCCIL" placed at Appendix 3.

4.2.5 If any equipment/item other than covered at Para 4.2.3 and 4.2.4 above is proposed to be procured, then the same must be proven being in regular use as per 'Proveness criteria' laid down in Para 5 of "Procedure Order for Cross Acceptance/Approval of Software Embedded Electronics Systems and New/Imported Technology Products for DFCCIL", placed at Appendix 3. . Such items/equipment shall be based on well-known National/International Standards. Details of the same should be submitted well in advance for review without objection by the Engineer.

(End of Chapter 4)

CHAPTER 5: CONSTRUCTION REQUIREMENTS

5.1 General

5.1.1 The construction requirements establish the overall procedures for the Contractor to follow for the Works that is related to the components manufactured off-site and supplied for installation, assembling and wiring of the Permanent Works. These requirements relate to their Manufacturing and installation in the system and associated activities.

5.1.2 The requirement of Construction/Installation Plan, Method Statement, Manufacturing/Procurement, Delivery, Storage and Installation at site are covered in detail in GS Vol. 1 Part 2. The requirement given here are specific requirements to be read in conjunction with the general requirements given in the GS.

5.1.3 The Contractor shall be required to demonstrate that the construction/installation system/procedure he has adopted would enable installation of equipment in the minimum time available commensurate with the project aims. The contractor shall identify and undertake the construction activities that are possible to be carried out away from the site and include them in his Construction/Installation Plan and Programme.

5.2 Installation

All the important Signalling equipment viz. EI, MSDAC, LED signals, IPS/UPS, Data loggers, point machines etc. shall be installed in accordance with RDSO/OEM's installation checklist. A certificate shall also be required to be issued by the OEM that the installation has been done in accordance with the Installation checklist and earthing and surge protection arrangements are adequate for satisfactory performance of the equipment. The equipment shall not be commissioned unless such a certificate has been issued by the OEM.

5.2.1 Indoor Installation

(1) All items of Signalling system comprising active electrical and electronic components shall, as far as possible be located in the Signalling equipment rooms.

(2) All wall-mounted equipment shall be installed at appropriate height to avoid any hazards to the person passing by. The Contractor shall ensure the fixture is of sufficient strength to hold the wall-mounted equipment in a secure and safe manner. Sufficient space shall be provided to allow for front maintenance access of the wall mounted equipment.

(3) All floor mounted equipment cabinets in the equipment room shall be securely bolted to ground, properly aligned and levelled. Racks/cabinets shall be suitably protected against entry of rodents, lizards etc. and also from effects of vibrations generated from train movements. All cable entries shall be sealed using suitable cable sealing system. The floor mounted equipment cabinets shall be arranged in a way to allow sufficient space at the front and rear side of the cabinets for maintenance access.

(4) The equipment layout within the equipment room shall be designed to:

(a) Allow sufficient clearance for escape out of the equipment rooms in case of emergency.

(b) Allow sufficient space at the front and at the back of the equipment for the maintainer to attend to the equipment freely without obstruction.

(c) Allow required space around the equipment as mandated by the OEM/RDSO specification.

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

(a) Drawings showing the equipment layouts and positions of the racks, cabinets and enclosures.

(b) Racks, cabinets, layout drawings showing the arrangement of individual module.

(c) Specifications, sample of all the mounting brackets and accessories.

(d) Equipment mounting and installation methods.

(e) Schematic diagrams and wiring diagrams of the System.

(f) Electrical distribution schematics within the room including the earthing details and

(g) Cable route diagrams for cables within the room.

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

5.2.2 Signalling Structures

(1) For housing the Signalling Indoor equipment, at least the following structures shall be provided at each location.

(a) One Signalling equipment room (SER) for housing Signalling equipment.

(b) One Signalling Power Supply Equipment room for housing Signalling Power supply equipment including batteries.

(2) The size/layout of SER will depend on the number of indoor equipment units, their size and installation as per contractor's design and equipment layout approved by the Engineer. The size of the SER shall be determined keeping provision of a 19" rack for future provision for TPWS and further space for a 19" rack for any future expansion/modification requirement.

(3) The Signalling Equipment rooms and Signalling Power supply equipment rooms for housing the Central Interlocking Unit at Stations are being built under CP 201 & 202 as part of Station building. The Contractor shall coordinate with contractor of CP 201 & 202 for construction of the same. The Station Building Plans are given in Part 4 - Reference documents. The air-conditioning of SER at Stations is being provided under CP 204 and for which too, the contractor should do the required coordination. The additional building if any, required for housing object controller/EI of distributed interlocking at the Station shall be built by the Contractor.

(4) The building of Signalling Equipment rooms and Signalling Power supply equipment rooms in the block section is within the scope of present contract and their number and location will be determined by Signalling design. These Signalling structures shall be located, to the extent possible near the Railway Level Crossings and adjacent to the Telecommunication structures. The Signalling power supply equipment rooms can be combined with the Telecommunication power supply rooms where they are co-located. The contractor shall provide the ventilation and air-conditioning of these rooms in accordance with relevant provisions of this specification.

(5) Opening/closure of Signalling Equipment rooms at the station and in the block

sections shall be indicated on the SM's Control Terminal and Signalling maintainer's S&D workstation at the Station, and at the OCC.

(6) Arrangement for remote monitoring of the air-conditioning system, temperature-regulator equipment and air-circulation equipment of Signalling Equipment Rooms, Telecom Equipment Rooms and Signalling and Telecom Power supply Equipment rooms from OCC shall be provided, as part of S&D system

(7) Portable Fire Extinguishers shall be provided in all the Signalling equipment rooms and Power supply equipment rooms at the Station and Auto Location Huts. Portable fire extinguishers shall be compliant to NFPA 10 standard and suited for electrical equipment fires.

(8) Smoke and Fire detection system will be provided in all Signalling Equipment rooms and Signalling Power supply equipment rooms with facility of alarm generation at station and OCC, under Contract Package 204. The Contractor shall do the necessary coordination for implementation of the same.

5.2.3 Outdoor Installation

(1) All the ducts/ troughs/pipes for laying cables will be provided by the contractor, except the following, which will be provided under Contract Package CP 201 & 202:

(i) At LC gates

- 2X200mm dia. RCC pipes across the formation near the gate lodge.
- 1X200mm dia. RCC pipe across the road surface on both sides near the lifting barriers.

(ii) At Crossing Stations

- 2X200mm dia. RCC pipes across the formation near the centre line of the station yard.
- 1 X 200mm dia. RCC pipe at both ends of the station yard near the facing points for the loop lines

(iii) At Junction Stations/Yards

- 3X200mm dia. RCC pipes across the formation near the centre line of the station yard.
- 2X 200mm dia. RCC pipe at both ends of the station yard near the facing points for the loop lines
- 1X 200mm dia. RCC pipe at both ends of the station yard near the outermost crossovers.

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

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

(4) All trackside equipment and the mounting method shall be designed in a way to minimize frequency of preventive maintenance and theft and vandalism.

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

(a) Specifications, sample of all the mounting brackets and accessories.

(b) Equipment mounting and installation methods and

(c) Schematic diagrams and wiring diagrams of the System.

5.3 Signalling Cable Laying, Termination and Testing

5.3.1 Signalling Cables

(1) The Cables for carrying outdoor Signalling circuits shall be PVC insulated, PVC sheathed and armoured unscreened cable conforming to IRS specification IRS: S-63/2007. The cable conductor shall be of annealed copper having minimum cross sectional area of 1.5 sq. mm.

(2) The Cables for carrying Signalling power supplies outdoor shall be aluminium conductor, minimum conductor size 25 sq. mm, PVC – insulated armoured, unscreened, underground power cable as per specification IRS: S-63/2007 & IS: 1554 (Part-2). The size of conductor shall be so selected as to suit the electrical load.

(3) The Quad cable used for Axle Counter circuit shall be 4/6 quad Telecom underground Jelly filled cable as per IRS specification TC-30/2005.

(4) The Optic Fibre Cable for the Signalling system shall be provided under PS (Telecommunications) Part 2, Volume 3. The Signalling system shall interface with the Telecommunication system for the same.

(5) Indoor cable/wire used shall be single/multi core, plain annealed high conductivity copper conductor, PVC insulated unarmoured as per IRS S-76/89. All electronic equipment shall however, be wired as per the requirement of the relevant RDSO specification of the equipment and /or as specified by the OEM. The contractor shall take prior approval of Engineer if indoor cable/wire other than RDSO approved are proposed to be used.

(6) All cables shall be adequately rated for their current carrying capacity. All power cables shall be able to withstand full load current for peak operation. The Contractor shall comply with the latest edition of IEE Wiring Regulations.

(7) A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. Labels shall be provided at about 100 m spacing on complete length of all sizes of cables. Type of labels to be used shall be got approved from the Engineer.

(8) The DWC-HDPE pipe/duct used for protection of Signalling cables below the track or any other place shall be supplied to RDSO specification RDSO/SPN/204/2011.

5.3.2 Cable core allocation

(1) A cable core distribution plan shall be prepared for each installation.

(2) Preferably, 6/12/19/24/30 core signalling cables shall only be used to keep low the inventory requirement.

(3) Adequate spare conductors to a minimum of 20% of the total conductors used shall be provided for in each main cable. All branch/tail cables shall have at least 10% spare cores or 2 cores, whichever is more. The spare conductors shall be provided in the outermost layer. All spare cores shall be made through up to the end points and terminated. Two nos. of 12 core dedicated spare cable may be

provided in the station area from Home signal to Home signal and terminated in all locations for instant transfer of these dedicated conductors during cable failure and cable testing.

(4) Where a number of cables have been used, the circuits shall be so distributed that the cables can be disconnected for maintenance purpose with the least possible dislocation to traffic. Line wise and if necessary function wise cables shall be provided. Auxiliary signals shall be taken in different cables. .

(5) A separate cable shall be used for operation of each point/crossover.

(6) All the power cables shall be laid with redundancy i.e. 2 power cables for each circuit, with a changeover arrangement at either end.

(7) UP and DN track vacancy detection systems shall be in different cables. Cables for Main and Supervisory Track vacancy detection systems shall be separate.

(8) The Quad cable laid shall have one quad reserved for Emergency communication being provided under PS (Telecommunications) Vol. 3 Part 2. The quad cable used for signalling functions and emergency communication shall also have 20% (of the total conductors used) spare conductors.

5.3.3 Cable Route Plan

(1) After deciding the size and the number of conductors in the different types of cables to be used on a route, a foot survey along the track shall be done to determine the best route for the cable.

(2) While planning the cable route, any future yard modification etc. shall also be kept in view.

(3) As far as possible low lying areas, platform copings, drainages, hutments, rocky terrains, points and crossings, shall be avoided.

(4) The cable route plan shall show the actual alignment of track, giving offsets from permanent way or permanent structures. The diagram shall indicate the various road and track crossings, crossing with power cables, water and sewage lines and other items of importance.

(5) All cable routes shall be carefully coordinated with all the interfacing parties. The cable trenching work shall be taken in hand only when the cable route plan has been approved by the Engineer.

5.3.4 Storing & transportation of cable

(1) Cable drums shall not be stacked on flat side. Suitable stoppers shall be placed for stability.

(2) Cable drums shall have easy access for lifting and moving.

(3) When rolling the cable drum either for unloading or transportation, the drum shall always be rotated in the direction of the ‘arrow’ which is marked on the drum.

(4) The drums shall not be rolled over objects that could cause damage to the protective battens of the cable.

(5) When unloading is carried out from the vehicle the drum shall not be dropped on the ground directly to avoid damage due to impact. Fork lifter or ramp shall be used.

(6) During all stages of storage, it is essential that the ends of the cable are effectively sealed by end cap or in any other approved manner to avoid water entry into the cable.

(7) It is desirable that cable drums are stored in covered shed to protect against direct exposure to sun/rains.

5.3.5 Paying out the cable

(1) For paying out cables, the cable drums shall be mounted on cable wheels. It shall be ensured that no kink is formed while paying out the cable.

(2) Cable drum shall never be kept on its side and cable uncoiled since this can result in twisting of cable conductors resulting in damage to them.

(3) The drum on the wheel shall be brought to one end of the trench and the end of the cable freed and the cable shall be laid along the trench.

(4) The cable drum shall be brought as close to the cable trench if possible. The cable drum shall clear the ground by 5 to 10 cm.

(5) The wooden battens on the drums shall be carefully removed shortly prior to laying and before the drum is mounted on the jack.

(6) A party of labourers shall move along the trench carrying cable at suitable intervals so that cable is not damaged due to dragging along the ground or bent unduly.

(7) The in-charge of cable laying shall ensure proper synchronization of all labourers for smooth laying.

(8) In cases where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.

(9) In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.

(10) Whenever mechanized equipment is used, the work shall be carried out by a trained operator under the supervision of the Engineer or its authorized representative.

(11) Where the cable drum is in damaged condition the cable may be placed on a horizontal revolving platform and the cable paid out in the same manner as given in paras above.

(12) Paying out of cable shall be done by rotating the cable drum and not by pulling the cable with excessive force.

(13) Wherever flaking of cable is required, it shall be done by making a succession of loops in the form of Figure ‘8’, these loops being disposed on top of each other to avoid tangling of cable. Figure of ‘8’ flaking shall only be carried out under the direct supervision of an experienced official.

5.3.6 Excavation and backfilling of the trenches

(1) Manual trenching is recommended for laying of Signalling cables in the station yards from Home to Home signal and mechanized trenching is recommended from Home signal and beyond into block/automatic section.

(2) Digging of trench between IR track and DFC track shall be manual or mechanized as proposed by the contractor and approved by the Engineer for every Station & Block section separately.

(3) Excavation of cable trench shall be made in all kinds of soils including clearing roots of trees, rocks, etc. During excavation, the earth of the trenches shall not be thrown on the ballast. The earth shall be thrown by the side of the trenches away from track.

(4) Trenches shall be straight as far as possible and steep angles shall be avoided.

(5) The width of manually made cable trenches shall be commensurate with number of cables. The minimum width shall be kept as 0.3 metres.

(6) It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.

(7) Before commencement of the laying, inspection of the trench and inspection of protection works shall be carried out by the Engineer so as to ensure their conformity with the specification.

(8) After cable has been laid and until the whole of the cables to be laid in the trench have been covered with their protective covers, no sharp metal tool such as spades, crowbar or fencing pins shall be used in the trench or placed in such a position that they may fall into the trench.

(9) For road/platforms/railway track crossing, trenchless horizontal directional drilling (HDD) technique shall be adopted under the supervision of competent staff for laying of GI/DWC-HDPE pipe. Both ends of GI/DWC-HDPE pipes shall be closed properly using accessories and the pits shall be properly backfilled. There shall be no damage to the road/platform/tracks or any such structures etc. enrooted during or after the HDD operations.

(10) Backfilling of the trenches shall be done properly. The earth excavated shall be put back on the trench rammed and consolidated.

5.3.7 Cable Laying underground

(1) The cables may be laid underground, either in the trench, in ducts, in cement troughs, in pipes or in any other approved manner.

(2) The cables shall generally be laid keeping in view all the relevant provisions of Signal Engineering Manual of IR and the Joint Procedure order for undertaking digging work in the vicinity of S&T underground cables (Annexure-I of Appendix 4).

(3) Before commencing work on any part of the site, the Contractor shall ascertain that the Engineer and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed the cable route. The Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served.

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

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

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

(7) All cables shall be laid along the track preferably one metre inside the EDFC boundary. If it is necessary to lay the cable outside the EDFC boundary, permission shall be obtained before starting the trenching.

(8) The cable laid parallel to the track shall be buried at a depth of minimum 1.0 metre (top most cable) from ground level However, in case of rocky soil, the depth may be reduced suitably. When it concerns the laying of tail cables which serve the track apparatus etc., the depth shall not be less than 0.50 metres.

(9) No sharp object like stone chips, iron pieces etc. shall ever come in contact with laid cables irrespective of the method of laying the same. The bottom of the cable trench shall be levelled and got rid of any sharp materials. In the soft ground, the cable shall be laid at the bottom of the trench previously levelled. In both the above cases, the cable shall be covered with a layer of sand or sifted earth of 0.10 metre thickness and thereafter a protective cover of trough or a layer of bricks shall be placed.

(10) A typical arrangement of Cable Trench is shown in sketch no. SDO/CABLE LAYING/003 at Annexure-III of Appendix 4.

(11) A typical arrangement of position of trenches for cable laying in Station area and Block Section has been shown in sketch No. GGM/Signal/Indicative drawing No. 1 and GGM/Signal/Indicative drawing No. 2 placed at Annexure-II (a) of Appendix 4 and Annexure-II (b) of Appendix 4 respectively

(12) The cables used for providing redundancy/ring circuit in signalling circuits shall be laid in different trenches/ducts, separated by DFCCIL/IR track(s). In case, if site conditions necessitate that the trenches/ducts are to be made on the same side of DFCCIL track (not separated by DFCCIL/IR track(s)), then it should be done with the prior approval of the Engineer with two trenches made with separation of at least 4 metres, and trench/duct farther from the DFCCIL track having depth of 1.7metres. Wherever 4 meters separation is not available/achievable, the cable laying shall be done as proposed by the Contractor and approved by the Engineer.

(12) At each end of the main cable an extra loop length of 6 to 8 metre shall be kept.

(13) Before starting cabling work, location boxes shall first be erected so that cable after laying is directly taken inside location box and its multiple handling/damage by re-digging and taking inside location box/Relay Room is eliminated.

5.3.8 Cable Laying in Electrified area

(1) The cable shall be laid at not less than one meter from the nearest edge of the mast supporting the catenary or any other live conductor, provided the depth of the cable does not exceed 0.5 meters. When the cable is laid at a depth greater than 0.5 metres, a minimum distance of 3 metres between the cable and the nearest edge of the O.H.E. structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in concrete/heavy duty HDPE/Ducts or any other approved means for a distance of 3 metres on either side of the Mast. When so laid, the distance between the cable and mast may be reduced to 0.5 meters. The precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.

(2) In the vicinity of traction sub stations and feeding posts, the cable shall be laid at least one metre away from any metallic part of the O.H.E. and other equipment at substation, which is fixed on the ground, and at least one metre away from the substation earthing. In addition, the cable shall be laid in concrete or heavy duty HDPE pipes/or other approved means for a length of 300 metres on either side of

the feeding point. As far as possible, the cable shall be laid on the side of the track opposite to the feeding post.

(3) In the vicinity of the switching stations, the cable shall be laid at least one metre away from any metallic body of the station, which is fixed in the ground, and at least 5 metres away from the station earthing. The distance of 5 metres can be reduced to one metre provided the cables are laid in concrete pipes/heavy-duty HDPE pipes/ducts or any other approved means.

(4) Where an independent Earth is provided for an OHE structure, i.e. where the mast is connected to a separate Earth instead of being connected to the rail, the cables shall be laid at least one metre away from the Earth.

(5) Where there are O.H.E. structures along the cable route, the cable trenches shall as far as possible, be dug not less than 5.5 metres away from the centre of the Track.

5.3.9 Laying of different type of cable in same trench

(1) The OFC cable shall be laid in HDPE pipe as per Telecom manual. The cables other than OFC shall be laid directly in the trench (both Signalling & Telecom cables).

(2) Where several cables of different categories have to be laid in the same trench, they shall be placed as far as possible in the following order starting from the main track side, so that in the event of failures, the maintenance staff may easily recognize the damaged cables:-

(i) Telecommunication cable

(ii) Signalling cable

(iii) Power cable

(3) A distance of approximately 10 cm must be maintained between Telecommunication cable and Signalling cables. The Signalling cables must be separated from power cables by a row of bricks between them.

5.3.10 Cable laying in ducts

(1) When cables are laid in rocky area, it is desirable to protect them with split RCC ducts of suitable design.

(2) Cables for longer distances shall be laid on bottom layer. Duct shall be filled with sand after cable is laid to avoid entry of rodents.

(3) The ducts shall be of such design as to prevent collecting the water in the duct.

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

(5) When cables are laid in trunking, care shall be taken to see that no ballast or stones have been dropped inside the trunking. The trunking shall be cleared of all ballast and stones before the cover are secured. When the ends of covers are joined together with cement plaster, a piece of paper or wood shall be placed under the joint to prevent the cement plaster from falling on the cable.

(6) After placing the trunking in the trench the ducts have to be aligned using 8 mm rod. For this purpose, a hole is left in the trunking for insertion of rods. Wherever there is a diversion proper care shall be taken to cover the cables, either by smoothly forming a curve with duct or a masonry structure can be constructed to

protect the cables. After laying of cables the ducts shall be covered with RCC slab and shall be continuously plastered at the end with trunking.

(7) Where it is necessary to take the cables between the tracks, it shall be carried in trunking kept sufficiently below the ballast level.

5.3.11 Cable Laying in Solid & Rocky soil

(1) In case of rocky soil, the depth may be reduced suitably.

(2) Sharp edges on the sides must be smoothened out and bottom of the chase shall be levelled. In the rocky ground the cable shall be laid normally on layer of sifted earth of 0.05 metres thickness previously deposited at the bottom of the trench. Cable shall be covered with the layer of sand or sifted earth of 100 mm thickness.

(3) In case sharp edge of rocky ground cannot be protected with sifted earth, concrete/GI/CI/PVC/DWC-HDPE pipe shall be used if numbers of cables are small. If number of cables is large, RCC duct shall be used. In isolated cases, it can be given smooth surface by using either masonry bricks or cement concrete.

(4) A row of bricks shall then be placed lengthwise on the top and jointed with cement mortar and a layer of concrete with cement plaster shall be provided on the top of the same.

(5) A sketch No. SDO/CABLE LAYING/008 showing laying of cables in rocky area is placed at Annexure-IV of Appendix 4.

5.3.12 Laying in special soil condition

Cable shall not be run through abnormally high acidic or alkaline soil or through sewages. If this is unavoidable special measures shall be taken to prevent corrosion. Cable may be laid in the concrete/GI/CI/PVC/DWC-HDPE pipes properly jointed to prevent ingress of moisture.

5.3.13 Cable laying in residential area

When laying the cable in residential area, the cable shall be specially protected on both sides up to a distance of about 300 metres beyond the building line. In such cases, the cable shall be protected by means of concreting of 50 mm as proposed for rocky soil. This is better than using bricks as in a residential area bricks are usually found while digging and its special significance of cable protection may be overlooked.

5.3.14 Track crossing

(1) As far as possible, the cable shall be crossed from one side of the yard to the other, at minimum number of locations.

(2) Track crossing shall be through trenchless method. The following precaution shall be taken:

(a) The cable crosses the track at right angles.

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

(c) The cable is laid in concrete/GI/CI/PVC/DWC-HDPE pipes or suitable ducts or in any other approved manner while crossing the track.

(d) Cable laid across the track must be 1.0 metre (minimum) below the ground level.

(e) No digging shall be done below the sleepers.

(f) A sketch No. SDO/CABLE LAYING/009 showing track crossing is placed at Annexure-V of Appendix 4.

5.3.15 Road crossing

(1) Road crossing shall be done through trenchless method. The cable shall be laid in concrete/GI/CI/PVC/DWC-HDPE pipes or in any other approved manner while crossing the road at the depth of 1 metre from the ground level. It shall extend 1 metre (minimum) on each side of the road keeping in view the future increase of width of the road.

(2) When crossing roads, it is necessary to lay the cables in such a manner as to avoid the necessity of bending the cable sharply and minimize the excavation of road surface as far as possible.

(3) The crossing of main roads often involves difficulties, especially if traffic is heavy. Precautions to avoid accidents to workmen, pedestrians and vehicles shall be taken. On minor roads, which can be temporarily closed to traffic it is possible to open up across the entire width of the road, pipes shall be installed quickly in the cutting, which is then filled in there by reducing to a minimum the time for which the road is closed.

(4) Some roads, which are broad, may be opened for half their width allowing the other half for use of traffic, pipes are laid, trench filled in the first half and the other half opened up after the first half is opened half is linked with those laid in the first half.

(5) Whenever a cable is laid across an important road, particularly one with a special surface, space for future expansion may be provided. Either of the following methods may be adopted:-

(a) The size of the pipe shall be so chosen that provision for laying of additional cables in future is kept. Pipes having diameters ranging from 100 to 200 mm are suggested, or

(b) A spare pipe may be laid, through which a cable can be drawn when required. It will be advantageous to leave a lead wire of G.I wire in the pipe for drawing the cable in future.

(6) A separate pipe of suitable diameter shall be used for telecommunication cable.

(7) A sketch No. SDO/CABLE LAYING/010 showing road crossing is placed at Annexure-VI of Appendix 4.

5.3.16 Cable laying on bridges/culverts

(1) Wherever practicable, the cable may be taken underground across the drain bed at a suitable depth for crossing small culverts with low flood level. A sketch No. SDO/CABLE LAYING/011 showing cable laying on culverts with low flood level is placed at Annexure-VII of Appendix 4. Wherever cable may not be taken underground across the drain bed, cable shall be taken on the culvert through GI/DWC-HDPE pipe of suitable sizes. A sketch No. SDO/CABLE LAYING/012 showing cable laying on culverts with high flood level is placed at Annexure-VIII of Appendix 4. The CST contractor (CP 201 & 202) is to provide ducts on the concrete bridges and culverts. The same may be used by the contractor for laying of S&T cables.

(2) When cables have to cross a metallic bridge, they shall be placed inside a metallic through which may be filled, as an anti-theft measure, with sealing compound. The cable shall be supported across the bridge in a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent 2 to 3 meters shall be made available at the approaches of bridge. A sketches No. SDO/CABLE LAYING/013 & 014 showing cable laying on metallic bridges are placed at Annexure-IX & Annexure-X of Appendix 4.

(3) In case of arch bridges, cable shall be taken through GI/DWC-HDPE pipes on top of the arch adjoining the parapet wall. The pipe shall be covered with ballast.

(4) Concreting of 50 mm shall be done throughout from entry/exit end of cable up to diversion point including slope on either side. The entry and exit ends of the cable from the pipe to the diversion point of the cable shall be concreted for 1 metre (minimum).

(5) As the laying involves movement of a large number of staff over the bridge the line shall be blocked and flagman posted on other side. On a double line only the line near which cable is being laid shall be blocked but care shall be taken to see that staff is aware of this and measures taken to prevent staff from straying on to the unblocked line.

(6) Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation, pier of bridge to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

(7) In order to prevent theft and miscreant activities on approach of cable to bridge/culvert where it is not possible to ensure adequate depth, concrete protection is proposed.

5.3.17 Cable Laying in monsoon season

(1) Cable laying in monsoon when the precipitation is heavy shall be avoided. The trenches will be inundated and visual inspection of the bedding of the trench will be rendered difficult. Threading the cable in pipes will also be more difficult.

(2) When cable laying is necessary during the rainy season, the cable ends shall be inserted in a pipe sealed at one end and the pipe buried. Termination work shall be started only when there is likelihood of a clear weather for three to four days.

5.3.18 Laying of cable above ground

(1) Signalling cables for outdoor circuits shall not normally be laid above ground. In exceptional cases where it becomes unavoidable, the following precautions shall be taken:

(a) The cable shall be suspended in wooden cleats, from cable hangers or in any other approved manner so that no mechanical damage occurs to the cable even under exposed condition.

(b) The cable supports shall be so spaced as to avoid sag.

(2) Indoor Signalling cable shall normally be laid on ladders, channels or in any other approved manner. The cables shall be neatly tied/ laced.

(3) In AC electrified areas cables shall be laid underground only. For laying cables in RE area instructions laid down in Chapter XXII of SEM shall also be followed.

(4) All cables in OCC being provided in false floor shall be neatly secured on cable channels

5.3.19 Cable markers

Underground Cable Route shall be identified by Electronic Cable Markers directly buried inside the trench at 30-40 m interval and at diversion points with the approval of Engineer.

5.3.20 Entry of cable at cabin, relay room, location boxes etc.

(1) All cable entry points in the Equipment room, battery room, SM's room, location boxes, junction boxes etc. shall be sealed using modular based cable and pipe sealing system based on multi-diameter technology as per RDSO specification circulated vide letter no. STT/OFC/Misc/263/Vol. XIV dated 03.01.2008. The modules shall be made of low smoke index, halogen free cross linkable rubber compound based on EDPM (Ethylene-Propylene Diene Terpolymer). A multi-diameter sealing module shall consist of two halves with removable layers and a centre core. One single module shall be able to seal cables of different diameters by peeling off layers. The sealing system must have built-in spare capacity i.e. option for adding more cables into the same system. All cable entries from/to adjacent rooms through overhead duct/ladder shall also be sealed.

(2) All cable entrance ducts must be closed with suitable masonry works, sand covered and plastering to prevent entry of rats etc. RCC slab shall be provided on the cable pit of the Signalling equipment rooms at the Station and auto location huts.

(3) Cable shall be protected on both sides up to a distance of 10 metre beyond building line of Signalling equipment rooms and battery room SM's room. In case of location/junction boxes, etc. cable may be protected for 1 metre on each side.

(4) Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation/masonry to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

5.3.21 Termination of cables

(1) No jointing of cables is permitted. All cables shall be terminated.

(2) The cable termination of Signalling cables shall be undertaken on approved type terminations on CT racks/ location boxes/junction boxes.

(3) All wire and cable conductors shall be clearly identified and numbered at each end using durable shrink on or tag type labels. A description of the terminating function shall be included. Each core so terminated shall be provided with identification marking on cable and on conductors/terminals and ferrules with letters or/numbers embossed on them as per requirement of circuitry. This will enable easy identification of conductors in case of any failures or cable disconnections or cable cut by outsider/miscreants. A proper marking and termination practice ensures quick and easy restoration during failures.

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

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

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

(7) The cable terminations shall be secured enough to withstand vibration level that is likely to be experienced in the DFCCIL environment.

5.3.22 Cable Termination Rack (CTR) and Location Box

(1) Cable Termination Rack (CTR) with 20% extra capacity for future expansion shall be provided.

(2) Only screw less terminals with isolation facility shall be used for cable terminations. The terminals and fuses used shall meet the requirements of RDSO specification No RDSO/SPN/189/2004. If any alternative terminal type is proposed for use, it should be got approved by Engineer.

(3) All external power/ signalling / data lines susceptible to lightning or high induced voltage shall be provided with Stage 3 surge protection devices as per Para 5.4.5(4)(c) of this specification.

(4) The Cable Termination Rack (CTR) shall be equipped with copper earth bar to which all cable shields shall be connected and soldered. The copper earth bar shall be connected to the earth.

(5) The Outdoor cables shall be terminated in Location Boxes.

(6) Location boxes shall be rugged and free from ingress of rodents, insects, dust, moisture and water.

(7) Location boxes shall be able to withstand vibration level, likely to be experienced alongside the track.

(8) Location boxes shall be theft and vandal proof as far as possible and shall be able to withstand the climate of the region.

(9) Cable entry points in the location boxes shall be filled with sand and plastered with cement.

(10) Separate Location boxes shall be used for UP and DN line cables.

(11) Where too many location boxes (say more than 10) are in close proximity between Starter and Home signal, location huts may be provided instead of location boxes for security, proper protection and ease of maintenance.

(12) All location boxes shall be provided with 110 V AC lighting arrangement with ON/OFF switch to assist maintenance/repair work undertaken during night.

(13) The foundation of Location boxes shall not be done on loose earth. It should be installed on concrete foundation. The foundation drawing shall be proposed by the Contractor and approved by the Engineer.

5.3.23 Testing of cable

(1) Before the cable is laid in the trench, a visual inspection of cable shall be made to see that there is no damage to the cable. It shall be tested for insulation and

continuity of the cores. Thereafter, the cable shall be laid into the trench. Record of insulation and loop resistant must be maintained.

(2) Testing of all main and tail cables after laying of the cable in trenches and also after termination in apparatus cases, in boxes and relay room shall be done.

(3) If any defect is noticed during the testing after laying the cable the same shall be replaced.

(4) The insulation resistance tests shall be made when conductors, cables and insulated parts are clean and dry. A 500V insulation tester shall be used for insulation testing. Any metallic sheath or metal work of any rack or apparatus case shall be bonded to earth during test.

(5) Insulation Resistance so measured shall not be less than 5 mega ohms per km at buried temperature. If the insulation resistance is found to be lower than 5 mega ohms, the cause shall be investigated and immediate steps taken to repair or replace the cable to prevent any malfunctioning of the equipment and circuits.

5.3.24 Supervision of cable laying

The work shall be supervised personally by an official authorized by the Engineer. The cable trench shall be inspected by the authorized person and jointly signed by him and the Contractor's authorized person before cable laying is undertaken. The record of joint inspection of the trench shall be maintained.

5.3.25 Earth Leakage Detector (ELD)

(1) ELD shall be provided to detect earth faults in the Signalling cables and circuits.

(2) ELD and alarms shall be provided at all the Signalling equipment rooms at the stations, block sections and at the OCC.

(3) ELD provided should cover all the Signalling cables and power cables.

5.4 Earthing and Bonding

5.4.1 General

(1) Earthing shall be provided for all Indoor & Outdoor Signalling installations to achieve the following objectives:

(a) Efficiently dissipate heavy fault currents and electrical surges, both in magnitude and duration, to protect equipment from being damaged so as to minimize down time, service interruption and replacement cost.

(b) Provide a stable reference for electrical and RF circuits at the installation to minimize noise during normal operation.

(c) Protection of personnel who work within the area from dangerous electric shock caused due to "step potential" or "touch potential".

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

(3) To achieve the secondary goal of providing protection for sensitive and

interconnected electronic and electrical systems, earthing shall be designed to minimize the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

(4) The Earthing and Bonding system shall meet or exceed the requirements of IEEE 1100, NFPA 780, IEC 62561-7 and IEC 62305.

(5) To minimize the effect of circulating earth loops and to provide equipotential bonding, “star type” bonding connection shall only be provided as required.

(6) The contractor shall submit the design for Earthing and Bonding of Signalling and Telecommunication systems for review and approval by the Engineer. OEM’s original data sheets of the proposed devices shall also be submitted along with the protection methods adopted in their design.

5.4.2 Indoor Signalling installation

(1) The Equipment rooms housing Indoor Signalling equipment and their Power supply shall be provided with suitable Earthing and Bonding system. A typical Earthing and bonding arrangement for Indoor signalling installation is placed at Annexure-I of Appendix 6.

(2) There shall be one equi-potential earth busbar for each of the equipment rooms viz. Signalling equipment room, Power supply equipment room etc. The equi-potential earth bus bars located in individual rooms shall be termed as Sub equi-potential busbars (SEEB). The equi-potential earth bus bar located in the Power supply equipment room directly connected to Class ‘B’ SPD and the main earth pit shall be termed as Main equi-potential earth busbar (MEEB).

(3) The EEB shall have pre-drilled holes of suitable size for termination of bonding conductors. The EEB shall be insulated from the building walls using low voltage fire resistant insulators. All terminations on the EEBs shall be using copper lugs with spring washers.

(4) All the equipment/racks in the Equipment room shall be directly connected to its SEEB. Each of Sub-equipotential earth busbar (SEEB) installed in the rooms shall be directly connected to Main equipotential earth busbar (MEEB) using bonding conductors.

(5) The routing of bonding conductors from equipment/racks to SEEB and from SEEB to MEEB shall be as short as possible and direct with minimum bends and separated from other wiring. The connection from SPD to MEEB shall be as short as possible and preferably without any bend.

(6) The connection between any two moving parts, like doors with Bonding Ring Conductor, etc. shall be connected by 316L Stainless Steel Flexible braids, which are UL listed, RoHS compliant and meeting IEC 60439.1 & IEC 61439.1.

(7) All bonding connections, whether it is from equipment or SPD to respective lugs on bus bars or of the Main earth bond with the Main Earth electrode, shall be with stainless steel nuts and bolts and exothermic welding while keeping in mind the conditions of UL listing, IEEE 837 & tamper proof weld metals.

(8) The Earthing system shall use maintenance free loop earth as per specification RDSO/SPN/197/2008 and shall be designed to give an earth resistance of less than 1 ohm. The design should be based on calculation methods as per IEEE 80

which require the parameters like target ohmic resistance value, soil resistivity, electrode length, electrode diameter etc.

(9) The earth electrode shall be made of high tensile low carbon steel circular rods, molecular bonded with copper on outer surface to meet the requirements of UL 467. The Ground Enhancement material should meet the requirement of IEEE 80's Clause 14.5 (d) and should be tested as per IEC 62561-7 standard. All the earth electrodes shall be bonded together using Galvanized Steel tapes or Copper Bonded Steel Conductors of suitable size in continuous length of max. up to 100 metre to achieve equipotential bonding.

(10) Despite the provision of earthing, as specified above, if failures of Solid state electronic equipment occur on account of finite earth resistance, particularly due to high voltage transients and lightning, further protection as necessary shall be provided.

5.4.3 Outdoor Signalling installation

(1) All the Outdoor Signalling equipment viz. Signals, Location boxes, Lifting barriers, track devices etc. shall be provided with suitable Earthing arrangement.

(2) The target earth resistance value for outdoor Signalling equipment shall be in accordance with the requirement specified for the equipment by the OEM/RDSO specification.

(3) The Signalling equipment having Solid State components and the enclosures housing them shall be provided with maintenance free earth using copper bonded steel electrode, earth enhancement compound and bonding connection through exothermic welding as per specification RDSO/SPN/197/2008.

(4) In order to arrive at the required target resistance value, the number of earth electrodes should be decided based on the calculations involving soil resistivity as per the standards above, all interconnected in parametric ring form or in parallel manner.

(5) Where the equipment to be earthed are in close vicinity they should be connected to a common earth in star configuration.

(6) For outdoor Signalling items installed in Location boxes, one earth busbar of suitable size shall be provided in each location box and earth point of all equipment and cable armour etc. shall be terminated on this busbar.

(7) GI wire as earthing bond shall not be used.

(8) A typical Earthing, Bonding and Surge protection arrangement for location boxes housing Electronic equipment is placed at Annexure-II of Appendix 6.

5.4.4 Lightning Protection

(1) All the structures housing Signalling and Telecom equipment viz. SER, TER and S&T Power supply Equipment rooms, shall be provided with lightning protection arrangements and protection against lightning surges travelling through conductors into equipment by using appropriate devices.

(2) The external Lightning protection arrangement shall have an air termination system, down conductors and Earthing system complete with accessories.

(3) The Lightning Air Terminal should be installed at a height at least 3m more than the top most projection of the building. In case there is a VHF antennae installed

on the building, the lightning protection should be so designed to safely overcome the competing features of the antennae as well as any other higher projections on the building.

(4) The air termination system shall be connected to the earth electrode of earthing system using down conductor of Copper Bonded Steel Conductor or any other suitable material as approved by the Engineer. The Down conductors shall be installed straight and vertical such that they provide the shortest and the most direct path to the earth.

5.4.5 Surge Protection

(1) The Surge protective devices shall be provided at the input and output power supplies to protect the Power supply equipment and the load equipment against any power surge due to lightning, switching, etc. The Surge arrestors shall also be provided for protection on external power/signalling/data lines.

(2) All surge protection equipment shall be grouped together in close proximity to the main earth bus bar and be physically and electrically isolated from other signalling equipment.

(3) The Surge Protection System provided to withstand the surge voltages shall be complying with IEC standards 62305, 61643, 60364.

(4) Surge Protection for Indoor Signalling equipment shall be provided as under:

(a) **Stage 1 Protection (at the input 230V AC supply in the power supply equipment room)**

(i) The Stage 1 protection shall consist of coordinated Class I/ B & II/ C type SPDs at the entry point of input 230V AC supply in Power supply Equipment room in TT configuration in a separate wall mountable box. The Class I/B SPD shall be provided between Line to Neutral & Neutral to Earth. There shall be a voltage switching device and tested as per IEC 61643 with the following characteristics and features:

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
1	Nominal Voltage (U_0)	230V	230V
2	Maximum continuous operating voltage (U_c)	≥ 255V	≥ 255V
3	Lightning Impulse current 10/350µs (I_{mp})	≥ 25KA	≥ 50KA
4	Response time (Tr)	≤ 100 ñs	≤ 100 ñs
5	Voltage protection level (Up)	≤ 2.5KV	≤ 2.5KV
6	Short circuit withstand and follow up current extinguishing capacity without back up fuse (I_{sc} & I_{fi})		
7	Temporary Over Voltage (U_T)	334Vmin. for 05 secs.	1200V min. for 200ms
8	Operating temperature / RH	- 25°C to + 80°C/ 95%	- 25°C to + 80°C/ 95%

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
9	Mounted on		din rail
10	Indication	Mandatory	Optional
11	Pluggability	Optional	Optional
12	Potential free contact for remote monitoring	Optional	Optional
13	Encapsulation	Encapsulated	Encapsulated
14	Degree of protection		IP20
15	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

(ii) The Class I/ B SPD will be followed by Class II/ C SPD adjacent to it and connected between Line & Neutral. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device, thermal disconnecting type and shall be tested as per IEC 61643 with the following characteristics and features: -

SN	Parameters	Limits (between Line & neutral)
1	Nominal Voltage (U_0)	230V
2	Maximum continuous operating voltage (U_c)	≥ 300V
3	Nominal discharge current 8/20μs (In)	≥ 10KA
4	Maximum discharge current 8/20μs (Imax)	≥ 40KA
5	Response time (Tr)	≤ 25 ñs
6	Voltage protection level (Up)	≤ 1.5 KV
7	Operating temperature / RH	- 25°C to + 80°C/ 95%
8	Mounted on	Din rail
10	Indication	Mandatory
11	Pluggability	Mandatory
12	Potential free contact for remote monitoring	Mandatory
13	Degree of protection	IP20
14	Housing	Fire retardant as per UL 94

(iii) Class I/B and Class II/C SPDs of Stage I shall be so coordinated that the voltage protection level of the coordinated devices is ≤ 1.5 KV. As such,

these devices shall be from the same manufacturer and necessary test certificate in this regard shall be submitted by the manufacturer/ supplier.

(b) **Stage 2 Protection (Power line protection at Equipment level)**

The Stage 2 protection shall consist of provision of Class II/ C type SPDs on 24V-110V AC/DC supplies at Equipment input level for protection against low voltage surges. The Class II/C type SPD shall be provided between Line to Neutral & Neutral to Earth. The device between Line to Neutral shall be a single compact Varistor of proper rating and in no case a number of Varistors shall be provided in parallel. It shall be voltage clamping device and thermal disconnecting type. The device between Neutral to Earth shall be a voltage switching device of proper rating. They shall be tested as per IEC 61643 with the following characteristics and features-

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
1	Nominal Voltage (U_0)	230V	230V
2	Maximum continuous operating voltage (U_c)	≥ 300V	≥ 255V
3	Nominal discharge current 8/20μs (In)	≥ 10KA	≥10KA
4	Maximum discharge current 8/20μs (Imax)	≥ 40KA	≥ 40KA
5	Response time (Tr)	≤ 25 ñs	≤ 100 ñs
6	Voltage protection level (Up)	≤ 1.5 KV	≤ 1.5 KV
7	Operating temperature / RH	- 10°C to + 60°C/95%	- 10°C to + 60°C/95%
8	Mounted on	DIN rail	DIN rail
10	Indication	Mandatory	Optional
11	Pluggability	Mandatory	Mandatory
12	Potential free contact for remote monitoring	Mandatory	Optional
13	Degree of protection	IP20	IP20
14	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

(c) **Stage 3 protection (Protection for Power/ Signalling/ Data lines)**

(i) All external Power/Signalling/Data lines shall be protected using preferably pluggable Stage 3 surge protection devices, consisting of a combination of

Varistors/Suppressor diodes and GD tubes with voltage and current limiting facilities.

(ii) These devices shall preferably have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. If the device has any component which comes in series with data/signalling lines, the module shall have make before break feature so that taking out pluggable module does not disconnect the line. This protection shall be in compliance to IEC 61643-21 & VDE 0845 Pt. 3 with the following characteristics:

Nominal Voltage (U_0)	5 V	12 V	24 V	48 V
Arrestor Rated voltage (U_c)	6 V	13 V	28 V	50 V
Rated Load current (I_L)	≥250 mA	≥250 mA	≥250 mA	≥250 mA
Total discharge current 8/20 μs (I_n)	≥20 kA	≥20 kA	≥20 kA	≥20 kA
Lightning test current 10/350 μs	≥2.5 kA	≥2.5 kA	≥2.5 kA	≥2.5 kA
Voltage protection level (U_p)	≤ 10 V	≤ 18 V	≤ 30 V	≤ 70 V

(iii) If the Power supply/Data/Signalling lines (AC/DC) are carried through overhead wires or cables above ground to any building or any location outside the equipment room, additional protection of Stage 2 (Class II/C) type shall be used at such locations for power supply lines and Stage 3 protection for Signal/data lines.

(End of Chapter 5)

CHAPTER 6: TESTING AND COMMISSIONING

6.1 General

6.1.1 The general details of Testing and Commissioning Philosophy, Strategy, Program, Plan and procedures is covered in General Specifications, Volume 1 Part 2. The specific requirements of Testing and Commissioning covered here shall be read in conjunction with the general requirements covered in GS.

6.1.2 Sequence of Tests

The sequence of tests shall generally comprise of the following:

(1) Type Tests, as and when required;

(2) Factory Acceptance Tests (FAT);

(3) Installation Tests;

(4) System / Sub-system Acceptance Tests (SAT);

(5) Integrated Testing & Commissioning; and

(6) Trial Run.

6.2 Type Tests

6.2.1 Type tests are performed on sample of Equipment prior to full production. Type tests are used to confirm that the proposed equipment is fit for purpose in the environmental conditions specified and meets the requirements of the specification including the EMC.

6.2.2 Type tests are not required to be conducted on Equipment procured as per Para 4.2.3 of this specification.

6.2.3 Type tests may be performed on Equipment procured as per Para 4.2.4 and 4.2.5 of this specification. However, the Type tests may be exempted if the Contractor is able to produce the Environmental and EMC test results earlier conducted on the Equipment and RDSO/DFCCIL are satisfied that the Equipment meet the required specification.

6.2.4 Type tests on equipment for which RDSO specification exists, if required shall be done as per applicable RDSO specification.

6.3 Factory Acceptance Tests

6.3.1 The FAT is carried out to demonstrate that each equipment/sub-system meets its functional specifications.

6.3.2 The FAT shall be carried out on all material, components, sub-assemblies, unit assemblies (including software, cables and wiring). No equipment or software shall be delivered to the Site until the Contractor has demonstrated, to the satisfaction of the Engineer that the equipment or software conforms to the specifications by carrying out the FAT. If any item/equipment whether as per IRS/RDSO specification or otherwise is proposed to be procured without FAT, the same should be done only with the prior approval of the Engineer.

6.3.3 FAT procedure shall be submitted for review by the Engineer Twenty Eight (28) days in advance of carrying out any Test.

6.3.4 The FAT shall be witnessed by Engineer/Employer's representative.

6.3.5 Where processor based equipment is to be used, the FAT shall also include verification of application software.

6.3.6 Factory acceptance tests shall include but not limited to:

(1) Physical inspection;

(2) Layout and equipment profile;

(3) Dimension check;

(4) Electrical check;

(5) Calibration;

(6) Output check;

(7) Operational performance;

(8) Insulation test;

(9) Soak test; and

(10) Interface tests with other equipment.

6.3.7 The EI application logic/software for every station and auto section will have to be tested completely for all tests including Control Table, Hot standby tests etc. as part of FAT. The controls/logic that are not possible to test at the FAT stage shall be identified and tagged for testing at SAT stage, in consultation with the Engineer.

6.4 Installation Tests

6.4.1 Prerequisites for Installation:

(1) Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and ensure for their dimensional accuracy.

(2) The Installation designs and drawings have been reviewed and approved by the Engineer.

6.4.2 Post Installation tests and Inspection:

(1) Post installation tests shall be carried out by the Contractor for each sub system following installation but before functional tests to demonstrate that the installation has been carried out correctly.

(2) The Contractor shall carry out installation tests for each sub-system following Installation but before SAT to demonstrate that the installation has been carried out correctly and equipment is properly housed and fixed.

(3) The Installation shall be inspected by the Contractor and witnessed by the Engineer. The Contractor shall submit a Post installation Inspection and testing Plan for Engineer's approval, prior to commencement of Post Installation inspection and testing.

(4) During the inspection, it shall be verified that

(a) The equipment has been installed as per the procedures and designs and drawings that have been reviewed by the Engineer and that equipment is correctly located and labelled.

(b) Any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

(5) The Contractor shall submit Installation Checklist of individual items/ equipment/subsystems based on the designs and submit it for Engineer's review at least 28 days before commencement of Installation.

(6) There shall be separate checklist for TMS, EI, MSDAC, IPS/UPS, Data loggers, Signals, Points machines, Cables, Location Boxes, earthing and Bonding etc. etc. Installation checklist issued by RDSO/OEM, where available shall be followed. The installation check list shall include Structure gauge checks to ensure the installations are carried out to the Schedule of Dimensions requirements;

(7) The Installation shall be inspected and witnessed by the Engineer/Employer's representative as per the Installation checklists and records maintained. The defects noticed during inspection shall be appended to/recorded on the Inspection checklists. Once the Contractor has rectified the defects, the same shall be verified by the Engineer and recorded. The Installation inspection records and Installation checklists shall form part of Installation test records.

(8) These tests shall culminate in SAT to verify the correct operation of all apparatus and where appropriate, correct response to the respective control commands or monitored function.

(9) Installation Tests

(a) After installation of the equipment, Visual inspection on un-energized equipment shall be carried out to check the following:

(i) Cleanliness;

(ii) Workmanship;

(iii) Confirmation of items conforming to ratings specified;

(iv) Water and dust proofing;

(v) Levelling, mounting and positioning;

(vi) Joints and connections tightness;

(vii) Cables – dressing, bending radii, jointing and finish at terminals;

(viii) Clearances and dimensions in conformity with drawings and SOD;

(ix) Earthing and bonding;

(x) Layout and Equipment profile check.

(xi) Protection devices;

(b) The Visual inspection shall be followed by (but not limited to) further Installation tests as under:

(i) Voltage measurements;

(ii) Continuity test as per wiring diagram;

(iii) Cable Insulation testing;

(iv) Power cubicle function test;

(v) Wire continuity tests;

(vi) Earth value measurements;

(vii) Wire count tests;

(viii) Software is correctly installed with the correct version and checksum;

(ix) Circuit board is of correct version and is correctly installed;

(x) Strap and Function tests;

(xi) Through circuit function test of the equipment;

(xii) Signal Sighting tests;

(xiii) Functioning of circuit breakers, isolating switches and their interlocks;

(xiv) Interface tests with other equipment.

6.5 System Acceptance Test

6.5.1 Once the Installation tests on individual items/equipment/subsystems are complete and they are interconnected and configured to form a complete system, the System Acceptance Test is carried out to ascertain that all the equipment supplied under this Contract satisfy the functional and specified performance requirements in all respects.

6.5.2 System Acceptance Tests shall comprise of comprehensive testing of the completely assembled installation to ensure that every item has been installed and adjusted and that all systems operate in every respect in accordance with the requirements of the specification and are ready for integrated testing and commissioning

6.5.3 The Contractor shall prepare and organize a comprehensive Program of Tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract, when installed, connected and configured as a complete system meet the specified performance requirements in all respects.

6.5.4 Prerequisites for commencement of the System Acceptance Tests (SAT):

(1) All documentation for the System Safety report have been submitted to the Engineer for review;

(2) All Installation Tests have been completed and test records submitted to the Engineer for review;

(3) Facilities for the maintenance of the system are in place; and

(4) The SAT Plan has been submitted to the Engineer for review at least one hundred and sixteen (116) days before the commencement of the SAT.

6.5.5 Verification and Validation of Application logic

(1) The FAT tested Application logic shall be loaded in the installed EI and verified to see that it meets the requirement of the Control table.

(2) Tests shall be carried out on each Signalling function to ensure that all the controls specified in the Control tables are present and effective.

(3) It is permissible for the application logic to be verified by use of simulation systems. The extent of verification testing by simulation shall be defined in the Test plan.

(4) Where a control is required to be in the Application logic but is not possible to test, this shall be stated in the test specification, together with any alternative testing to be performed to mitigate any reasonably foreseeable hazard.

(5) Functions commonly requiring to be tested include, but are not limited to:

(a) EI Hot standby tests;

(b) Point interlocking;

(c) Route interlocking;

(d) Sectional and sequential route releasing;

(e) Route initiation and setting;

(f) Approach locking;

(g) Train operated route release;

(h) Block controls;

(i) Level crossing controls;

(j) Emergency cancellations;

(k) Crank handle interlocking;

(l) Aspect sequence.

(6) Verification shall demonstrate that correct correspondence exists between all commands, controls, status detecting mechanisms and their indications, both within the integrated system and to any external interfaces.

(7) Validation of Application logic involves testing of the Application logic in accordance with the requirements of the relevant safety case and product application requirements. The validation activities shall be defined in the test specification.

6.6 Integrated Testing and Commissioning

6.6.1 Integrated Testing on Completion shall include the Work of other contractor(s). The Contractor shall, following satisfactory completion of tests on his works, equipment, sub-systems or system, perform, at the direction of the Engineer, Program of tests to verify and confirm the compatibility and complete performance of his works, equipment, sub-systems or system with the works, equipment, sub-systems or system provided by others.

6.6.2 The Contractor shall submit to the Engineer the requirements and procedures in respect of the Contractor's scope of work for Integrated System Tests in conjunction with the other contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria.

6.6.3 Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the railway systems operate satisfactorily between one another and meet all specified requirements for design, operability, safety, and integration with other works and systems.

6.6.4 Integrated testing and commissioning shall include the integration of the section (Mughalsarai-New Bhaupur) with the adjacent already commissioned sections including OCC, without disturbing the safety and revenue operation of the earlier sections.

6.6.5 Conducting of these Integrated Tests by the Contractor and the other contractors shall include a period of Trial Run.

6.6.6 The Contractor along with others Contractor(s) shall carry out all statutory tests and trials under the supervision of the Engineer, necessary for obtaining sanction of the competent authority, if required, for opening the Railway System.

6.6.7 The results of the Integrated Testing and Commissioning shall be documented.

6.6.8 If any Signalling equipment/sub system fails to pass Integrated Testing and Commissioning, the Contractor shall carry out at his own cost the necessary adjustment or modification to the equipment/sub system required to satisfy the requirements of Integrated Testing and Commissioning within such time as the Engineer may deem fit.

6.7 Trial Runs

6.7.1 On completion of Integrated testing and commissioning to the satisfaction of the Engineer and System acceptance test, the Contractor shall confirm in writing to the Engineer that the works provided by him under the contract is ready for the Trial runs.

6.7.2 During the Trial run, the Employer will run the actual trains. The objective is to check that the functions and operations of the various systems are satisfactorily integrated and to

allow all technical systems to settle and operating staff to become conversant with the working procedures.

6.7.3 The Trial run shall be made use for ensuring the following:

(1) Signal and indicators Sighting – approach sighting, focus, alignment, relationship with other signals, and interference from other sources of light (e.g. street lamps);

(2) Track Vacancy detection system operates correctly, reliably and continuously during presence/absence of a train; and

(3) Dynamic interfaces – Integrity of operation and indications across boundaries between different types of track vacancy detection equipment and between different interlocking;

(4) Checking for timing issues with level crossings;

(5) Confirmation that train describer stepping, and associated systems, works correctly, especially across boundaries;

(6) Specific types Signalling equipment could require a test train, especially where evidence of the correct operation of train / signalling equipment interfaces is required; and

(7) Verify the layout to the Signalling plan, as far as practicable.

6.7.4 The Engineer may issue instructions to the Contractor for particular works or actions required of him during this period. In addition, the contractor shall make good all defects and complete all outstanding works within the Trial period so as to permit the commencement of revenue operations.

6.7.5 The Contractor's personnel shall be available throughout the period of Trial run.

6.7.6 After the successful Trial Run and after obtaining statutory clearances / approvals from CRS and or other relevant authorities, the Works shall be commissioned with the consent of the Engineer.

6.8 Statutory Clearances

The Contractor shall obtain all the mandatory clearances required for commissioning of Signalling work. In such case, the Employer shall extend all the requisite help and assistance to enable inspection, tests, verification of test records and trial run by CRS.

The CRS sanction, if required will be applied for by the Employer. The Contractor will, however be responsible for preparation of all supporting documents required for CRS sanction.

(End of Chapter 6)

CHAPTER 7: DOCUMENTATION

7.1 General

7.1.1 Requirements of Documentation in general are covered in Chapter 5 and 6 of General Specifications Vol.1, Part 2, Section VI. This chapter mentions particular requirements of Documentation for Signalling System.

7.2 List Of Documents

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

7.2.1 Management Plans

As per Chapter 3, General specifications Vol. 1 Part 2 Section VI

7.2.2 Preliminary Design Submissions

(1) Design manual.

(2) System requirement specification

(3) Specifications of systems/ subsystems/equipment

(4) Identification of design codes and standards

(5) System Simulation Report

(6) Design Templates for Signal Interlocking Plan, Route Control Table, Detailed Design sheets etc.

(7) Preliminary System design

(8) Block diagrams showing information flow from site to station to OCC bringing out clearly the redundancies provided

(9) Signal Interlocking Plan (SIP) of one station and one block section

(10) Equipment proposal for Station, ALH, LC gate hut

(11) Equipment sizing for Station, ALH, LC gate hut

(12) Equipment layout Plan for Station, ALH, LC gate hut

(13) Preliminary Power Supply diagram for TMS

(14) Typical Power Supply diagram for Station, Auto location Hut, LC gate (away from ALH)

(15) Preliminary Power supply load calculation, for one Junction Station, one Crossing Station, Auto Location hut (with LC gates) , Auto Location hut (without LC gates)

(16) Preliminary climate management calculations. (Station/Auto location hut/LC gate hut)

(17) Survey Reports

(18) Earthing, Lightning & Surge protection plan

(19) Typical Axle counter location plans showing both Main and supervisory sections

(20) Typical Cable Core plan for Station and Block section

(21) Typical Cable termination details for track side devices such as axle counters, points, signals, LC gates etc.

(22) Location Foundation drawings

(23) Signal Foundation drawings

(24) Migration Plan for Phased removal of Level crossing gates

7.2.3 Detailed Design submissions

(1) Signal Interlocking Plans of Stations and Block sections.

(2) Route Control tables.

(3) VDU diagram.

(4) Control cum Indication panel Diagram at LC gate.

(5) System configuration showing EI connectivity.

(6) Equipment Layout Plans – OCC, Signal Equipment Room, Power Supply room, LC/ Auto Location Hut, Location/Junction Boxes, SM office.

(7) Cable Core Allocation - Station, Block section.

(8) Cable Route Plan - Station, Block section.

(9) Power supply Load Calculation for Stations (Junction & Crossing).

(10) Power supply Load Calculation for Auto Location huts (without LC gates)

(11) Power supply Load Calculation for Auto Location huts (with LC gates)

(12) Circuit Diagrams/Wiring diagrams.

(13) Application Logic of Stations and Block sections.

(14) Equipment Rack details.

(15) Cable Termination Rack Diagrams.

(16) Fuse Details.

(17) Relay Contact analysis.

(18) Configuration data, parameters and settings.

(19) Interconnection details for all equipment in SER.

(20) Track devices termination details.

(21) Cable termination details of locations/Junction boxes.

(22) Station Working Rule Diagrams.

(23) Detailed Signalling Power supply distribution arrangement at OCC, Station, Auto Location Hut, LC gate huts.

7.2.4 System assurance submissions

(1) System Assurance Plan including

  (a) System RAM Plan and

  (b) System Safety Plan

(2) Safety policy

(3) Hazard Analysis and Hazard Log

(4) Design/System Safety Studies and Report

(5) RAM Analysis and Prediction Report

(6) FMECA

(7) RAM Demonstration plan.

(8) Engineering Safety Validation Report

(9) Operational Safety case

7.2.5 Operation and Maintenance Manuals

Please refer to Chapter 14, General Specifications Vol. 1 Part 2 Section VI

7.2.6 Documents for CRS Sanction

CRS sanction supporting documents, including Station Working Rules (SWR), Gate Working Rule (GWR) etc.

(End of Chapter 7)

CHAPTER 8: SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

8.1 General

8.1.1 The Contractor shall provide Spare parts generally in accordance with the principles as given below. All Spare parts for which the Contractor has been authorized to provide through a written instruction by the Engineer shall be provided six weeks before commencement of train operations.

8.2 Supply of Spares

8.2.1 The Spare Parts to be supplied by the Contractor shall consist of:

(1) Commissioning Spares (as hereinafter defined);

(2) Defects Liability Spares (as hereinafter defined); and

(3) Contract Spares (as hereinafter defined).

8.2.2 Commissioning Spares

(1) The Contractor shall keep on the Site throughout the installation, erection and commissioning periods, sufficient stocks of Spare Parts ("Commissioning Spares") to enable immediate replacement of any item in the Permanent Works found to be defective or in any way in non-conformance with the Specification during the installation, erection and commissioning period.

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

(3) The Contractor shall ensure availability of 'Commissioning Spares' on or before the commencement of any System Acceptance Tests (SAT).

8.2.3 Defects Liability Spares

(1) The Contractor shall keep sufficient stocks of Spare Parts in an off-site location in their site office throughout the Defects Notification Period to enable rapid replacement of any item in the Permanent Works found to require replacement as part of the Contractor's obligations during the Defects Liability Period ("Defects Liability Spares").

(2) The Contractor shall submit the list of 'Defects Liability Spares', with the types and quantities of Spares the Contractor intends to hold, at least six (6) months before the commencement of the DNP, to the Engineer for review.

(3) The Contractor shall ensure availability of 'Defects Liability Spares' on or before the commencement of the DNP.

8.2.4 When the Contractor submits the list of 'Commissioning Spares' and 'Defects Liability Spares' for Engineer's review, the Contractor shall provide calculation to support the proposed types and quantities taking into account the following:

(1) The expected failure rate of the parts.

(2) Population of the parts in the system.

(3) Criticality of the parts in the system.

(4) Availability and MTBF figures of the system.

(5) Spare delivery lead time.

(6) Workshop repair turnaround time.

8.2.5 The Contractor shall keep and maintain sufficient stock of his own 'Commissioning Spares' and 'Defects Liability Spares'. The Contractor will not be allowed to use the 'Contract Spares' for his Installation & Commissioning and Defects Liability needs.

8.2.6 The Contractor shall include details of the stock of 'Commissioning Spares' and 'Defects liability Spares' it holds, in the Monthly Progress Report. The Stocks shall include status of the Spares in the stores and under workshop repair. .

8.2.7 **Contract Spares**

(1) The Contractor's supply of 'Contract Spares' shall be for Employer's operation and maintenance need.

(2) Following 'Contract Spares' shall be supplied:

SN	Item	Unit	Quantity
1	Underground cable	km	5% of the total cable laid subject to a minimum of 1 km of each type.
2	All other Cable & wires, other than Underground cables	m	5% of the total cable/ wire used / laid subject to a minimum of 100 meter of each type.
3	Power supply – cards, modules, equipment complete with interconnecting cables and connectors and all other associated accessories	Nos.	20% of each type installed subject to minimum of one.
4	Electronic Interlocking & Object Controllers (if any) – Control Terminal, cards, modules complete with interconnecting cables and connectors and all other associated accessories.	Nos.	20 % of each type installed subject to minimum of one.
5	Digital axle counter – cards, modules complete with interconnecting cables and connectors and all other associated accessories.	Nos.	20 % of each type installed. Subject to minimum of one card.
6	All rail mounted equipment complete with interconnecting cables and connectors and all other associated accessories.	Nos.	30% of each type installed. Subject to minimum of one.
7	VRLA batteries	Nos.	15% of each type installed. Subject to minimum of one.
8	Signals complete including Signal	Nos.	5% of each type installed. Subject to

SN	Item	Unit	Quantity
	posts, CLS units etc. Signal Lighting Units etc.		minimum of one.
9	LED Signal Lighting Units complete with current regulator, interconnecting cables and connectors and all other associated accessories.	Nos.	20% of each type installed. Subject to minimum of one.
10	Point machines including ground connections	Nos.	15% of each type installed. Subject to minimum of one.
11	Train Management system including networking equipment (except Server) and Video Walls at OCC, TMS terminals, FIU along with interconnecting cables and connectors and all other associated accessories.	Nos.	15% of each type installed. Subject to minimum of one.
12	Service & Diagnostic system including, Data loggers, data concentrators, HMU, CMU, FEP, LAN switch & other networking equipment (except Server) with interconnecting cables and connectors and all other associated accessories.	Nos.	15% of each type installed subject to minimum of one.
13	Electric Lifting Barriers	Nos.	100% of the total installed
14	MCB, surge protection device, fuses & terminals	Nos.	15% of each type installed. Subject to minimum of one.
15	All other interconnecting cables/ connectors not included above	Nos.	10% of each type installed. Subject to minimum of one.
16	Other items/equipment/ material.	Nos.	15% of each type installed subject to minimum 2 Nos.

(3) The Contractor shall submit list and quantities of each type of 'Contract Spares' at least 6 months before start of 'Defect Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ. All spares quantities shall be rounded up to the nearest deliverable unit.

(4) The List shall include information on make, model, serial number, rating, description, part number, drawing number, shelf life etc. of each item of 'Contract Spares'. The Contractor shall also identify the lead times for all the Spare parts. Parts with long lead times shall be specially identified in the Spares list. In the event that any of the spares identified have a particular shelf life or storage requirement, this shall be made known to the Engineer with the submission of the Spares list, including the necessary action for disposal or storage.

(5) The Spare Parts shall be manufactured at the same time as the Permanent

Works. All Spare Parts shall be works tested and inspected in accordance with the relevant quality system, suitably packed and labelled and delivered in accordance with Part 2, Section VI, Volume 1, General Specifications. Test certificates for each piece or set of equipment shall be submitted to the Engineer.

(6) Before the Spare Parts are delivered, the Contractor shall submit to the Engineer a shipment advice notifying details of shipment such as date of dispatch, vessel name, etc. as well as a packing list indicating the contract number, order number, the lot size, quantity and weight. The Spare Parts shall be consigned and delivered in accordance with the Engineer's instructions.

(7) The Contractor shall complete supply of the 'Contract Spares' on or before start of Defects Notification Period.

(8) The Contractor shall indicate the sources of supply of all 'Spares' and shall guarantee their availability during the design life of the project. For Spare Parts of consumable and high-use items, the Contractor shall ensure that a minimum of two alternative sources of supply are available.

(9) Spare Parts shall be fully interchangeable with their corresponding part. All Spare Parts shall be configured to the latest revision during the Defects Notification Period.

8.2.8 Special Tools and Test & Measuring Equipment

(1) Following Tools & Test equipment shall be supplied:

SN	Item	Unit	Quantity
1	General purpose Signalling tool kit consisting of screw drivers of various sizes; flat pliers, nose pliers, cutting pliers, etc. of various sizes; 500 gm. hammer; cable knife, flat chisel of various sizes; brass brush; nylon brush; steel measuring tape,; adjustable screw wrench of various sizes; soldering iron 220V, 60 W; solder wire; tin cutter; flat spanner/ box spanner/ ring/ flat spanner of various sizes; continuity buzzer; AC/DC analog Multimeter 2 nos. of Philips or similar make; AC/DC digital Multimeter Fluke or similar make; Megger one each for 100 V & 500V. All the tools shall be from reputed manufacturers and shall be supplied in a suitable carrying case.	Nos.	25
2	Megger 500/ 1000 V AC 0 to 200 M ohms with earth tester, electronic push button type of Philips or any other reputed make	Nos.	25
3	Portable digital auto range Multimeter, Philips/ Fluke or similar make capable to measure from 0.1 mV / 0.01 mA AC/DC up to 10 Amp. AC/DC, 600 V AC/DC and resistance from 0.1 Ohms to 40 M Ohms complete.	Nos.	25
4	Supply of heavy duty electric drill machine of size 31 mm 230V AC with hammering action complete capable of working on metal/ wood/ concrete complete with chuck and drill bits of various sizes for all three surfaces in a suitable carrying case from reputed manufacturers.	Nos.	25

SN	Item	Unit	Quantity
5	Supply of electric drill machine of size 6 mm and other description as per 4 above.	Nos.	25
6	Digital earth tester, 4 terminal, range 0-10/ 100 ohms with rechargeable battery complete with other required accessories in a suitable carrying case.	Nos.	25
7	Laptop based mobile maintenance terminal	Nos.	25
8	Complete tool kit for maintenance of EI as per the recommendations of the manufacturer in a suitable carrying case.	Nos.	1 at each EI
9	Complete tool kit for maintenance of DAC as per the recommendations of the manufacturer in a suitable carrying case.	Nos.	1 for each Evaluator of MSDAC.
10	Complete tool kit for maintenance of IPS as per the recommendations of the manufacturer in a suitable carrying case.	Nos.	1 for each IPS.
11	Special tools, test equipment including access ladders and protective gear for maintenance of gantry mounted signals if installed.	Set	10 sets
12	Computer based test set up with required software for automatic testing like 'Functional Testing' etc.	Nos.	Min. 2 Nos.

(2) These Special Tools & Test equipment are for use by the Employer during normal operation & maintenance after taking over of the installations. None of the Special Tools and Test equipment provided for the Employer shall be used by the Contractor on site prior to delivery. The Contractor shall make his own arrangement of Special Tools and Test equipment for use during Installation and Defects Notification Period.

(3) The Contractor shall submit list and quantities of each type of 'Specials Tools and test Equipment' at least 6 months before start of 'Defect Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ.

(4) The List shall include information on make, model, serial number, rating, description, part number, drawing number, details of calibration etc. of each item of 'Special Tools and Test equipment'.

(5) All Special Tools and Test Equipment shall be accompanied with drawings, schematics, assembly and connection drawings, circuit diagrams/descriptions, calibration instructions and Operation and Maintenance Manuals to enable them to be used by suitably skilled (but not necessarily specially trained) personnel in a non-hazardous manner and to achieve the desired result in terms of accuracy and quality.

(6) The Contractor shall provide the means and instructions which describe the parameters of each item of Special Tools and Test Equipment that are critical to their proper methods of use and which enable the Employer's staff using the Special Tools and Test Equipment to achieve the proper performance and operation. Such means and instructions shall include, but not be limited to, any routine checking or re-calibration needs for the Special Tool and Test Equipment

itself.

(7) The Special Tools and Test Equipment (together with the relevant calibration certificates) required to carry out all the functions described in the Operation and Maintenance Manual shall be suitably packed and identified in accordance with Part 2, Section VI, Volume 1, General Specifications, consigned and delivered in accordance with the Engineer instructions. The extent of supply shall include protective carrying cases as may be appropriate for the storage and use of each item. The supply of all 'Special Tools and Test equipment' shall be completed by the start of DNP.

(8) The Contractor shall indicate the sources of supply of all 'Special Tools and Test equipment' and shall guarantee their availability during the design life of the project.

8.2.9 The Contractor shall set up an off-line Testing platform at a suitable place provided by the Employer. The Test platform shall consist of all sub systems of Signalling in minimum configuration, inter connected together. The Testing platform shall have the capability to test Signalling equipment/components/sub systems of EI, MSDAC, TMS, IPS/UPS etc. The testing platform shall be commissioned before revenue operations.

8.2.10 At any stage if the Employer feels that the 'Contract Spares' and 'Special Tools and Test equipment' being procured are less, then it reserves the right to order additional quantities before expiry of Defects Notification Period, as a Variation to the Contract Price at an agreed Price. Computer based inventory management plan for 'Spares' and 'Special Tools & Test equipment' shall be established by the Contractor for use of the Employer.

(End of Chapter 8)

CHAPTER 9: DEFINITIONS AND ABBREVIATIONS

9.1 Definitions

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

9.1.2 **Auxiliary signals:** Shunt signals – Independent or below Main signals, Calling-on signals, Route indicators, 'A' marker & 'AG' marker lights for Semi-Automatic signals.

9.1.3 **Control Terminal:** An Industrial grade computer complete with hard disc, VDU display monitor, key board and mouse, provided with SM.

9.1.4 **Design life:** The design life is the period of time during which the system is expected to work satisfactorily within its specified parameters.

9.1.5 **Failure:** A failure is an event which causes loss of function or performance within any part of the Signalling & Train Control System and requires a maintenance intervention to restore full functionality and performance.

9.1.6 **Flank Protection:** Protection of a train running on route set for it from trains or vehicles on neighbouring lines through setting & locking of concerned points in required position.

9.1.7 **Fouling Point: The** position at the convergence of two tracks where the kinematic envelopes, one on each line, would come into contact.

9.1.8 **Graceful Degradation:** The transfer in quality **or performance** from the initial level to a lower operable level.

9.1.9 **Headway:** Minimum time interval between successive trains at any point on the line such that the speed of a train is not reduced by presence of any other train ahead.

9.1.10 **Independence:** The isolation between the investigating technician undertaking the work and a second person for example, responsible for checking or approving the work.

9.1.11 **Level Crossing:** Is the rail – road surface crossing.

9.1.12 **Man Machine Interface (MMI):** The visual interface between the controller and the control system. MMI consists of computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.

9.1.13 **Main running signals:** Home signal, Starter signal, Intermediate Starter signal, Advance Starter signal and Gate signals.

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

9.1.15 **Mean Time Between Failures (MTBF):** The average time between failures causing service delays for a piece of equipment, a system or a subsystem.

9.1.16 **Mean Time to Repair/ Restore (MTTR):** The average time being required to repair a piece of equipment, system or subsystem to restore to its proper working conditions.

9.1.17 **Reliability:** The probability that an item/equipment/system can perform a required function under given conditions for a given time interval.

9.1.18 **Running Lines:** The DFCCIL Running lines between Mughalsarai and New Bhaupur.

9.1.19 **Safety:** Freedom from unacceptable risk.

9.1.20 **Sub system:** Each system comprising Signalling system. E.g. EI sub system, TMS sub system.

9.1.21 **Supervisory Track Section:** A Section of track between two DPs completely covering more than one track sections. Supervisory Track Section is used to automatically reset Track Sections under its junsdiction.

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

9.1.23 **Traffic Controller;** The person deputed to control and regulate working of traffic on specified section of the railway provided with a system of speech communication.

9.1.24 **Track Section:** A Section of track between two DPs used for controlling the signal depending upon its clearance or otherwise

9.1.25 **Video wall:** A graphical representation of the railway and its global operating status.

9.1.26 **Vital Relay :** The relays associated with each track section & Supervisory track section.The status of vital relays indicate the clearance or otherwise of associated track section /Supervisory track section.

9.1.27 **Wrong side Failure:** A failure of a safety-critical system or subsystem which directly leads to a situation with the potential to cause harm, human injury, damage to property, plant or equipment, damage to the environment, or economic loss.

9.2 List Of Abbreviations

ABS	Automatic Block Signalling
AC	Alternating Current
ACO	Automatic Change over
ACTM	Alternating Current Traction Manual
ALH	Auto Location Hut
AT	Auxiliary Transformers/ Auto Transformer
CB	Circuit Breaker
CD	Compact Disc
CENELEC	European Committee for Electro Technical Standards (Comité Européen de Normalisation Electro technique).
CIU	Central Interlocking Unit
CMS	Crew Management System
CST	Civil, Structures and Track
CTC	Centralized Traffic Control
CTR	Cable Termination Rack
DAC	Digital Axle Counter
DG	Diesel Generator
DN	Down Direction
DP	Detection Point
DNP	Defect Notification Period
DLP	Defect Liability Period

ELD	Earth Leakage Detector
EI	Electronic Interlocking
ELB	Electric Lifting Barriers
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EN	Euro Norm
FIU	Field Interface Unit
FMECA	Failure Mode and Criticality Analysis
FRACAS	Failure Reporting and Corrective Action System
G&SR	General and Subsidiary Rules
GCC	General Conditions of contract
GPS	Global Positioning System
HDD	Hard Disc Drive/ Horizontal Directional Drilling
HDPE	High Density Poly Ethylene
Hz	Hertz
I/O	Input / Output
IEC	International Electro–Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMD	Integrated Maintenance Depot
IMSD	Integrated Maintenance Sub Depot
IPS	Integrated Power Supply
IRPWM	Indian Railway Permanent Way Manual
IRSEM	Indian Railway Signal Engineering Manual
ISA	Independent Safety Assessor
ISO	International Standards Organization
Km / KM	Kilo Meter
KVA	Kilo Volt Ampere
LAN	Local Area Network
LED	Light Emitting Diode
LC	Level Crossing
LRU	Lowest Replaceable Unit
LV	Line Verification
LVR	Line Verification Relay
MACLS	Multiple Aspect Colour Light Signalling
MIS	Management Information System
MCB	Miniature Circuit Breaker
MMI	Man Machine Interface
MSDAC	Multi Section Digital Axle Counter
MTBF	Mean Time Between Failure
MTTR	Mean Time To Restore

MTBSAF	Mean Time Between Service Affecting Failure
NMS	Network Management System
NDA	Non-Descript Alarm
OCC	Operations Control Centre
OEM	Original Equipment Manufacturer
OFC	Optic Fibre Cable
OHE	Over Head Equipment
PC	Personal Computer
RAM	Random Access Memory
RAMS	Reliability, Availability, Maintainability and Safety
RE	Railway Electrification
RSTR	Reset Relay
SCADA	Supervisory Control and Data Acquisition
S&D	Service and Diagnostic
SOD	Schedule of Dimension
SER	Signalling Equipment Room
SP	Sectioning Point
SPAD	Signal Passed at Danger
SSDAC	Single Section Digital Axle Counter
TDS	Train Describer System
TMS	Train Management System
TPC	Traction Power Controller
UPS	Uninterruptible Power Supply
UFSBI	Universal Fail Safe Block Interface
UP	Up Direction
VDU	Video Display Unit
VRLA	Valve Regulated Lead Acid

(End of Chapter 9)

Appendix 1

Working Methodology for Operation of LC Gates

(Extract of CTPM/NCR's letter no. : T/Gen./LC/Inst./04/05 dated 14.11.2014 & 08.05.2014)

I. Operation of Level Crossing gates when DFCC and IR tracks are on the Parallel Alignment and Automatic Block System of Working is in force on DFC as well as IR and the Level Crossing Gate is Interlocked with DFCC and IR System and Normal position is 'OPEN' to road traffic:

1.0 Normal position of the lifting barriers shall be 'OPEN' to road traffic.

2.0 Single set of electrically operated common lifting barriers shall be provided outside both the Railway and DFC tracks so as to protect both the Railway as well as DFC tracks.

3.0 The Gateman shall work under the Administrative control of Railway.

4.0 The booms shall be interlocked with the gate signals on DFC as well as IR system and wherever required gate signal and automatic signal will be clubbed.

5.0 There will be single gate hut and single Gateman to operate the lifting barriers in each shift. An additional gateman will be provided by DFC, wherever required.

6.0 A common indication panel shall be provided in the gate hut, wherein the indications for the 'On' and 'Off' aspect of gate signals for both the systems as also the occupation/clearance of the controlling track circuits up to the point of approach warning shall be displayed. Direction of movement of the trains shall also be displayed in the panel.

7.0 An operating panel for the operation of the booms shall also be provided wherein buttons for raising/lowering of booms as also for stopping them midway during operation shall be provided so that the booms can be stopped during operation should a vehicle come under the booms or enter into the level crossing gate during closure.

8.0 Arrangement for manual emergency operation of the booms shall also be provided which can be used when it is not possible to close the booms electrically due to some defect or otherwise.

9.0 Road signals as well as hooter shall be provided to warn the road users regarding the approach of a train. The road signals shall normally show a steady yellow aspect towards the road users.

10.0 As soon as the train reaches a predetermined point of 8 Kms on DFC and 5 Kms on the IR track in rear of the gate, a buzzer will start sounding in the gate hut intimating the Gateman of the approach of a train. Hooter shall also start sounding simultaneously to warn the road users of the proximity of a train. The Gateman shall thereafter get ready to close the gate in time against road traffic for the passage of the train. As soon as the lowering of booms is started, the road signals shall start displaying a flashing red light towards the road users which shall turn to steady red when the booms are fully lowered.

11.0 Another warning buzzer shall also sound when the train reaches a distance of 4 Kms on DFC and 2 Kms on the IR system if the gate is in open position. If the gate is already in closed position, the buzzer shall not sound but an indication shall be displayed in the indication panel and track locking of the booms shall take place so that the booms cannot be opened thereafter till the passage of the train from the level crossing. The gate signals shall assume 'off' aspect.

12.0 After passage of the train from the level crossing, the Gateman shall open the gate for the passage of road traffic after ensuring from the indication panel that no train is approaching on the IR/DFC track.

13.0 Arrangement for fixing of safety chain shall also be provided in case of failure of lifting barriers. Indication for fixing of safety chain shall also be provided on the panel of Station Master. An arrangement shall be provided for talking off the relevant gate signal when the safety chain is properly locked and detected by the system.

14.0 Procedure for closure of the gate:

As soon as a train leaves a station on IR/DFC system, the concern Station Master shall intimate the Gateman that the train has left. If, however, the running time of the train from the station to the level crossing is less than five minutes, the Station Master shall intimate the Gateman as soon as the train leaves the station in rear so that the gateman has enough time at disposal to close the gate for the passage of the train. The Gateman shall thereafter be ready to close the gate in time to pass the train.

As soon as the train reaches a predetermined point of 8 Kms on DFC/ 5 Kms on IR in rear of the gate, a buzzer will sound in the gate hut and indication regarding the approach of the train will appear in the indication panel. The Gateman shall then immediately close the gate against road traffic by operating the relevant button taking care that no road vehicle is trapped inside the gate or under the lifting barriers.

As soon as the booms are fully lowered, the relevant gate signal shall assume 'off' aspect. After passage of train from the level crossing, the same shall be opened to pass road traffic after ensuring from the track indications on the indication panel that there is no train either on DFC or IR track.

15.0 Provision of Sliding Boom:

Gate shall be provided with one additional sliding boom on each side of power operated lifting barrier. Each sliding boom will be parallel to the existing power operated lifting barrier of it's side and would normally so positioned that the complete body of the boom is laying away from the road i.e. no part of the sliding boom shall normally project on to the road leading to the L.C. gate. The sliding booms installed are meant to be used in the case of emergency when the power operated lifting barrier are damaged or closed indication is not found due to any reason.

II. Operation of Level Crossing gates when DFCC and IR tracks are on the Parallel Alignment and Automatic Block System of Working is in force on DFC as well as IR and the Level Crossing Gate is Interlocked with DFCC and IR System and Normal position is 'CLOSED' to road traffic:

1.0 Normal position of the lifting barriers shall be 'CLOSED' to road traffic.

2.0 Single set of electrically operated common lifting barriers shall be provided outside both the Railway and DFC tracks so as to protect both the Railway as well as DFC tracks.

3.0 The Gateman shall work under the Administrative control of Railway.

4.0 The booms shall be interlocked with the gate signals on DFC as well as IR systems and wherever required gate signal and automatic signal will be clubbed.

5.0 There will be single gate hut and single Gateman to operate the lifting barriers in each shift. An additional Gateman will be provided by DFC, wherever required.

6.0 A common indication panel shall be provided in the gate hut, wherein the indications for the 'On' and 'Off' aspect of gate signals for both the systems as also the

occupation/clearance of the controlling track circuits up to the point of approach warning shall be displayed. Direction of movement of the trains shall also be displayed in the panel.

7.0 An operating panel for the operation of the booms shall also be provided wherein buttons for raising/lowering of booms as also for stopping them midway during operation shall be provided so that the booms can be stopped during operation should a vehicle come under the booms or enter into the level-crossing gate.

8.0 Arrangement for manual emergency operation of the booms shall also be provided which can be used when it is not possible to close the booms electrically due to some defect or otherwise.

9.0 Road signals as well as hooter shall be provided to warn the road users regarding the approach of a train. The road signal shall normally show a steady red aspect towards the road users.

10.0 As soon as the train reaches a predetermined point of 8 Kms on DFC and 5 Kms on the IR track in rear of the gate, and if the gate is in open position, a buzzer will start sounding in the gate hut intimating the Gateman of the approach of a train. The Gateman shall thereafter get ready to close the gate in time against road traffic for the passage of the train. As soon as the lowering of the booms is started, hooter shall also start sounding to warn the road users of the proximity of a train. At this time, the road signals shall start displaying a flashing red light towards the users which shall turn to steady red when the booms are fully lowered.

If the gate is already in the closed position, the buzzer shall not sound but only an indication shall be displayed in the indication panel.

11.0 Another warning buzzer shall also sound when the train reaches a distance of 4 Kms on DFC and 2 Kms on the IR system if the gate is in open position. If the gate is already in closed position, the buzzer shall not sound but an indication shall be displayed. At this stage, if the gate is in closed position, track locking of the booms shall take place so that the booms cannot be opened thereafter till passage of the train from the level-crossing. The gate signals shall assume ‘off’ aspect.

12.0 After passage of the train from the level crossing, the Gateman shall open the gate for the passage of road traffic, if required, by checking from the indication panel that no train is approaching on the IR/DFC track.

13.0 Arrangement for fixing of safety chain shall also be provided in case of failure of lifting barriers. Indication for fixing of Safety chain shall also be provided on the panel of Station Master. An arrangement shall be provided for talking ‘off’ the relevant gate signal when the safety chain is properly locked and detected by the system.

14.0 Whenever the gate is required to be opened for the passage of road traffic, following action shall be taken by Gateman:-

(i) The gate shall be opened for the passage of road traffic when no train is anticipated on the DFC as well as IR system by checking from the indications available in the indication panel.

(ii) The position of trains on the DFC as well as IR tracks shall be known to the Gateman from the indications in the indication panel.

(iii) The Gateman shall remain extra vigilant during the time the gate is open to road traffic and shall be prepared to close the gate in time for the passage of a train if any on the DFC/IR track.

(iv) After passage of the road traffic, the Gateman shall lower the lifting barriers to close the gate against road traffic and keep them in that position until required again for passage of road traffic.

15.0 Provision of Sliding Boom:

Gate shall be provided with one additional sliding boom on each side of power operated lifting barrier. Each sliding boom will be parallel to the existing power operated lifting barrier of it's side and would normally so positioned that the complete body of the boom is laying away from the road i.e. no part of the sliding boom shall normally project on to the road leading to the L.C. gate. The sliding booms installed are meant to be used in the case of emergency when the power operated lifting barrier are damaged or closed indication is not found due to any reason.

(End of Appendix 1)

Appendix 2

Uninterruptible Power Supply System - Technical Specifications

1. General

(1) The UPS and battery backup equipment shall conform to latest versions of following international standards covering Safety, construction, electromagnetic interference and operation. In case of any conflict, more stringent requirement shall apply

RFI Suppression	EN 55022A or VDE 0878
Boost cum float charger	IEC 60146, DIN-41772
General & Safety requirement	IEC 62040-1-1
EMC requirements	EN 50091-2, EN 50091-3
Protection class	IEC- 60950
Compliance to Quality Standards	ISO 9001-2008 & ISO 14001
Automatic Transfer Switches	IEC 60947-6-1, UL 1008 Listed
VRLA Batteries	IRS: S 93-96, IEEE485 Sizing
Protection against Lightning	IEC 62305
Railway applications – Surge arresters and low-voltage limiters for specific	IEC 61992
Transient Voltage Surge Suppressors	IEEE C62.41 Sizing, UL1449-3 Listed
Overall UPS System	IEC 62040-3, IEC60146

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

(3) Provision of suitable earth leakage detection and alarms shall be made individually at each location (Auto Location/station etc.).

(4) Conceptual design of the UPS and the battery backup for Signalling and Telecommunication Systems is as per attached Single Line Diagrams. (Annexure I & II of Appendix 2). The contractor shall submit detailed design separately for Stations, Auto Locations and OCC for review by the Engineer.

(5) OCC UPS System shall have Load Bus Synchronization (LBS) Panel to ensure same parameters like frequency and voltage etc. in both buses. Supply to single source critical load shall be through free standing independent external static switch which will be connected from both Buses for its input sources as shown in Single Line Diagram (Annexure II of Appendix 2). External Static Switch shall be as per specifications mentioned in Para no -12 of this document.

2. System Operation

The UPS system shall be designed to operate in the following modes:

(1) **Normal**

The incoming power supply reaching the UPS Modules through an Input Isolation Transformer shall be rectified into regulated DC voltage for charging the battery and powering the inverter to supply the loads.

(2) **Emergency**

Upon failure or fluctuation of the incoming supply beyond acceptable limits an Automatic Transfer Switch shall detect and transfer/switch to the other incoming source so that supply to the UPSs and Stabilizer is maintained. In case of absence / failure or fluctuation of both the Input Supply sources, the battery banks of the UPS shall, without interruption, supply DC power to the UPS inverters to supply the loads. When incoming mains supply is restored or returned to the specified limits, the rectifier shall resume normal operation automatically without disturbance to the loads. During this transition of the DC Supply to Inverter, from Rectifier to Battery and vice versa, there should not be any switching delay since the Battery bank will be directly connected to the Rectifier-Inverter DC Bus and Floating on the DC Bus. Inverter shall not be connected to its input DC Bus through any switching devices or reverse blocking diodes

(3) Automatic Transfer Switch shall be a self-powered equipment having complete overlapping neutral, in-phase monitor and operated by a single solenoid, with microprocessor based controller suitable for 230 V / 415V, 50 Hz supply. The ATS shall be conforming to UL-1008 and shall be 3rd party tested with a circuit breaker back up for withstand and close on rating (WCR). The ATS shall be tested for AC-33iA/AC-33A utilization category and shall have inbuilt voltage, frequency and single phasing protection.

(4) **Parallel Redundant Operation**

Normally, both the 100% rated Inverters will be supplying to the Load sharing it on 50:50 basis. In the event of internal failure/tripping of any one Inverter, there shall be no transfer of load, rather the faulty Inverter shall isolate itself giving adequate alarm indication and the healthy Inverter, which was already sharing 50% of the load, shall continue to work unaffected, taking-up the full 100% load.

(5) **Automatic in-built Static Bypass**

In the event of the inverter output fault or fault leading to tripping of both the 100% rated Inverters, the in-built Static Switches of Inverter Output and Static Bypass Line shall automatically transfer the loads to the stabilized bypass without any power discontinuity / interruption provided the frequency of the mains input source is within the acceptable band (it is assumed that the bypass source being stabilized, its voltage will always be within the tolerance of the loads). When the inverter output recovers to a suitable level, the switch shall automatically restore the load from the stabilized bypass source to the inverter output.

(6) **In-Built Manual Bypass**

Each UPS Module will contain 100% rated manual bypass path to allow a no-interruption (i.e., make-before-break) transfer of the loads to the stabilized bypass source for safely carrying out simultaneous online checks/maintenance of the two UPS Modules. Adequate interlock shall be provided to prevent operation of the manual bypass switch when both the Inverters are healthy and supplying to the loads.

(7) **External Super-Bypass**

A manual external Super-bypass system shall be provided to allow the UPS modules to be completely isolated for maintenance/repair requiring de-energization of UPS Output terminals or physical relocation/movement of UPS's. Warning labels and adequate interlocks shall be provided to prevent the bypass supply being connected to UPS output terminals while the UPS is healthy and running.

3. Equipment Design of UPS

(1) The audible noise level at 1.5 m radii of the panel, over a load range 10% to 100% full load shall not exceed 56 dBA for UPS Systems rated 30 KVA or below, 65 dB A for UPS Systems between 30-60 KVA and 70dBA for UPS Systems rated between 60-120 KVA.

(2) The UPS system provided by the Contractor shall be sized to power its full connected load of the Signal & Telecommunication systems working in parallel redundant configuration with at least 20% spare capacity. The back-up shall be for a total period of four hours (2 hours for each UPS Module at full load).

(3) Each Parallel redundant UPS System shall include adequately rated Automatic Transfer Switch and Input Isolation Transformer, 2x100% rated Rectifier-cum-charger, 2x50% rated battery banks, 2x100% rated IGBT PWM inverters, 2x100% rated output isolation transformers, 1x100% rated Servo Controlled Voltage Stabilizer, 2x100% rated Static Bypass Lines (i.e. 4x100% rated Static Switches), 2x100% rated Manual Bypass lines Switches, 1x100% rated Super-Bypass Line and all associated control circuitry to make the system complete. Failure of any single component shall not cause failure of the total UPS.

(4) The UPS shall be self-contained floor mounted, bottom entry, metal-clad type with front access. UPS shall be supported on a base frame of at least 150mm height.

(5) Power supply for the Signal & Telecommunication systems shall have the UPS back-up. The UPS system shall be designed with 100% parallel redundancy with four hour battery backup (each UPS Module should have separate individual battery bank rated 50% i.e, to deliver backup to full load for 2 hours). The two separate 50% Battery Banks will normally work as independent battery banks connected to their respective UPS Modules and shall have provision of their interconnection / paralleling in order to achieve full 100% capacity (i.e. 4 hour backup) in case of simultaneous failures of any one Inverter and all the Input AC Supplies.

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

(7) Two independent redundant 1-Phase / 3-phase primary power supply will be made available by 'Other Contractor' on the LT Panel provided by him in the OCC. The

Contractor shall coordinate with the 'Other Contractor' and carry out all works required to draw the primary power supply from the LT Panel to the UPS.

(8) Ripple content in intermediate DC

- With Battery : < 1%
- Without Battery : < 2%

4. Parameters Applicable to UPS

(1) System Input Characteristics:

The primary power for the rectifier shall be provided from the switchboards with the following characteristics :

Voltage	415 V, +10%, -20% (for 3-Phase Input Systems) 230 V, +10%, -20% (for 1-Phase Input Systems)
Frequency	50 Hz, +/- 1%
Power Factor	Not less than 0.8 lagging when the system is operating at full load and nominal voltage.

(2) System Output Characteristics

(a) UPS ratings shall be subject to approval by the Engineer based on Load sizing calculations submitted by contractor during detailed engineering.

(b) **Output Voltage Requirements**

Voltage	400V, 3-Phase, four wires (for 3-Phase UPS Systems). 230V, 1-phase, two wires (for 1-Phase UPS Systems).
Frequency	50 Hz nominal, +/-1% regulation (free running)
Voltage regulation	Static: Better than +/- 1 % Dynamic: Better than +/- 5% (0-100-0% Load Step)
Distortion factor	For linear load: < +/- 1%, For 100% non linear load having Crest Factor of 3:1): < +/- 5%.
Crest factor (sustainable by UPS without de-rating)	3:1

(c) **Output Voltage Stability**

The steady state output voltage shall not deviate by more than +/- 1% from no-load to full-load. The allowable transient output voltage variation is +/-5% and the system output voltage shall return to +/- 1% within 20ms.

(d) **Output Frequency Regulation, Stability and Slew Rate**

The UPS shall be capable of providing the nominal output frequency within 50 Hz +/- 1% when the UPS inverter is not synchronized to the incoming mains. When the UPS Inverters are synchronized to Main Frequency, the frequency variation range will be limited to the synchronizing window of 50

Hz +/- 2 Hz. UPS should have facility to set the synchronizing window between +/-1 Hz, +/- 2 Hz, +/-3Hz. The rate of tracking with Mains Frequency (Slew Rate) shall be 1 Hz per sec.

(3) **System Overload**

Overload capacity (better than) : 150% >60 seconds

: 125% >10 minutes

: 110% >60 minutes

The short circuit current limit shall be set at 155% of the rated output current.

(4) **Output Voltage Harmonic content**

The total harmonic distortion (THD) of Inverter Output Voltage waveform as generated by the UPS Modules shall be less than 1% for Linear Loads and less than 5% for 100% non-Linear Loads having crest factor of 3:1. Harmonic Distortion for any single harmonic shall be maximum 3%.

(5) **Efficiency (AC-AC)**

The UPS System including the Isolation Transformers shall have an AC-AC efficiency of 85% minimum at full load. The AC-DC Efficiency of each Rectifier-Cum-Charger / Inverter at full Load and while catering full Charging current to Battery, shall be 98%.

(6) **Electromagnetic Interference**

Filters shall form an integral part of the UPS to prevent any form of electrical noise or radio frequency interference being generated that may affect the critical load.

(7) **Current Limiting**

The rectifier/charger shall have input current limiting at 115% so as to disallow any current other than the maximum requirement due to Load Current through Inverter/s and Battery Charging Currents.

(8) **Input Power Walk-In**

When the mains are restored following an outage, the power and current drawn by UPS modules shall be initially minimum and slowly shall rise to required level in 10-15 sec. to drive the critical load and the additional pre-set power to recharge the batteries as described above.

5. Battery Banks & Sizing

(1) The battery bank shall consist of two nos. of 50% rated banks of high quality heavy duty maintenance free valve regulated lead-acid (VRLA) 2V Cells having 20 Year designed Float Life, each bank connected to its individual UPS Module, capable of maintaining supply to its inverter at full load for not less than 2 Hours in the event of failure of mains supply or rectifier.

(2) The two Battery Banks will be normally, separately connected with their respective UPS Modules and give 4 hour backup during normal operation of the two Inverters in Parallel Redundant configuration where each Inverter is loaded 50%. Further, there will be provision of Interconnection/Paralleling between the two Battery

Banks to achieve 100% rating (4 hour backup) in the event of Input Supply failure during single UPS Module operation (other Module Inverter faulty or not in circuit).

(3) It shall be possible to Isolate individual battery bank and work on it and still have 50% (2 Hours) Backup Power availability from the UPS System to the Loads.

(4) The battery racks shall have anti acid painting and adequate insulations. The battery racks shall be properly insulated and earthed.

(5) The battery shall be adequately designed to reduce all possible voltage drop between cells and battery plates and battery plates to conductors bars.

(6) The life of the battery bank shall not be less than 7 years. The Contractor shall submit documents to verify the life of batteries.

(7) Separate, externally wall-mounted independent, adequately rated battery circuit breakers for protection shall be provided between the battery bank and the individual UPS modules thereby, isolating the battery bank from the rest of system. The Battery Circuit Breakers (2 Nos. in each set of 2x100% rated UPS) shall have thermal, magnetic as well as under voltage remote tripping mechanism so that they can be remotely tripped from the UPS front panel.

(8) The battery shall be sized for float voltage of 2.25 Volts per Cell and nominal voltage of 2 Volts per cell suitable for the satisfactory operation of the system and total autonomy of 4 hours. The Contractor shall submit detailed battery capacity calculations to the Engineer for review and approval as per the following minimum requirements:-

(a) Full KW rating of Inverter Output at 0.8 lagging P.F.

(b) Inverter Efficiency at 50% Load (maximum value to be considered for Battery Sizing shall not exceed 90% for 6 KVA, 93% for 30 KVA , 93.5% for 60 KVA and 94% for 120 KVA UPS's)

(c) Minimum End Cell voltage of 1.75 VPC

(9) Four no. of 2V Cells as per manufacturer and a Spare Cell Charger for charging up to 6 cells at 10% of Battery AH Capacity shall be supplied as Spares with the main supply.

6. Rectifier-cum-Charger & Sizing

(1) The power rectifiers shall be 1-Phase / 3 Phase, Full-wave, Fully-controlled, SCR Bridge Type/IGBT. A separate adjustable DC current limit circuit shall be provided for battery charging current. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of value of inverter input current.

(2) Rectifier shall be designed to ensure that the total harmonic distortion in the input current to rectifiers as seen by the supply source Bus, is in line with the IEEE std. 519-1992 recommendations.

(3) The Rectifiers shall be sized based on the maximum inverter load and the nominal rated capacity of the battery. The DC load imposed by inverters shall be considered under the worst case where only one rectifier is feeding both inverters.

(4) The rectifiers shall be designed to completely charge their individual battery to 90% capacity within maximum 10 hours after complete discharge. Facilities shall

be provided to initiate battery boost charge operation by manual and automatic means as and when the Battery may require.

(5) The DC regulator shall sense the battery charging current and shall adjust the DC bus voltage to ensure constant current charging.

(6) Rectifier-cum-Charger should have temperature compensated dynamic Charging wherein, sensing higher ambient around the battery banks, the charging voltage should get automatically regulated at the rate of minus 2 - 3 milli-volt per Deg. C above the desired 27 Degree C. For this, vendor should supply temperature sensors to be fixed at the Battery Bank.

(7) UPS System should have Online Battery Testing feature from UPS front Panel.

(8) In line with DIN 41772 I-U Characteristics the Rectifier-Cum-Charger should automatically shift from Float to Boost Mode and vice-versa based on current demand sensing and have an over-riding Boost charge timer settable in 1-15 Hour range.

(9) Each Rectifier should have adequate rating to simultaneously cater full Battery Charging current and Inverter Current at full load considering that One Rectifier may have to cater charging current to both the 50% rated Battery Banks plus Inverter on full Load. The contractor shall submit detailed rectifier sizing calculations for review of the Engineer as per the following minimum conditions :-

(a) Total Rectifier Current = Inverter Input DC Current at full load + 2x10% of Battery AH Duty.

(b) Total Rectifier Power Rating (in W) = Rectifier Float level (at 2.25VPC) x Total rectifier current

7. Static Bypass Transfer Switch

(1) A static bypass transfer switch Module shall be provided as an integral part of the UPS. This will consist of two sets of 100% rated Static Switches – one for Inverter Output and the other for Static Bypass Line. The control unit shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions to provide an uninterrupted transfer of the load to the stabilized bypass source without exceeding the transient limits specified herein when a malfunction occurs in both the UPS Inverters or an external overload condition occurs.

(2) The static bypass transfer switch shall be a fully Solid State static switch having anti-parallel SCR's that has a maximum transfer time of less than 4 millisecond in Synchronised condition and less than 20 millisecond in Unsynchronised condition. The static switch shall be capable of supplying 125% rated current for 10 minutes, 150% for 60 seconds and 1000 % for one cycle.

(3) A transfer of load to the bypass supply shall take place in any of the following abnormal conditions:

(a) Inverter overload capability exceeded.

(b) Inverter output voltage exceeds the overvoltage trip level of 110% or under voltage trip level of 90%.

(c) D.C. over voltage.

(d) D.C. under voltage.

(e) UPS fault and

(f) UPS over temperature.

(4) Whenever the load is on the static bypass line, the control panel shall provide an indication of this status. The audible alarm shall sound appropriately. If the transfer was due to a momentary overload and was automatically restored to the UPS module after the overload was removed, the alarm and indicator shall automatically reset.

(5) The Voltage stability of the Stabilized Bypass source (Servo Controlled Voltage Stabilizer) providing supply to the Static Bypass, Manual Bypass, and Super-Bypass lines should not exceed 230V / 415 Vac +/- 2% in steady state conditions.

8. Enclosures

Following requirements for enclosures shall be met:

(1) Minimum degree of protection as per EN 60529:

IP31: for Stations & OCC

IP42: for Auto Location Huts.

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

(3) Finish as provided by OEM.

(4) Lockable access doors.

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

(6) Forced ventilation fans: Required.

(7) Internal and External interlocking, padlocking, earthing, insulation, screening of enclosures.

(8) Protection against natural corrosion and galvanic corrosion of dissimilar metals.

9. UPS Monitor, Control and Information System

(0) The UPS system shall be equipped with a status panel to provide monitoring and control of the complete system. Basically, the system shall be able to display the following Alarms and Alerts on the System Front Panel LCD Screen upon their occurrence. If more than one Alarm occurs, they will be displayed in the Screen in continuous cyclic order:

(a) Output overvoltage

(b) Output switch open

(c) Rectifier switch open

(d) Battery C.B. open

(e) Manual bypass closed

(f) Bypass: absent

(g) Bypass: overvoltage

(h) Bypass: under voltage

(i) Bypass: frequency error

(j) Bypass: phase rotation error

(k) Bypass: off

(l) Load on bypass

(m) Rectifier: off

(n) Rectifier: blocked

(o) Rectifier failure

(p) Inverter: off

(q) Inverter: blocked

(r) Inverter: over temperature

(s) Inverter: unsynchronized

(t) Inverter: overvoltage

(u) Inverter: under voltage

(v) Output: under voltage

(w) Battery: under test

(x) Battery: test failed

(y) Battery: on load

(z) Battery: end discharge

(aa) Battery: boost time expired

(bb) DC bus: fast overvoltage

(cc) DC bus: under voltage

(dd) Overload shutdown

(ee) Over temperature shutdown

(ff) Emergency stop

(gg) Overload

(hh) Battery earth fault

(ii) Inverter: failure

(jj) Inverter: parallel error

(kk) Over-temperature failure.

(1) **System Metering**

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

(a) Output voltage (line-line)

(b) Output voltage (line-neutral)

(c) Output current (line)

(d) Output real power (line)

(e) Bypass frequency

(f) Inverter frequency

(g) Bypass voltage (line-line)

(h) Battery voltage

(i) Battery current

(j) Output apparent power (line)

(k) Temperature (battery room) - optional

(l) % line load

(m) % battery charge.

(2) System Controls

The following minimum user controls shall be provided on Front panel of each UPS Module:

(a) Alarm reset push-button.

(b) Inverter ON/OFF or Transfer to Static Bypass membrane switch.

(c) Emergency shutdown button with protective cover.

(3) System Mimic Diagram

A system mimic diagram using light emitting diodes (LEDs) shall be provided on the equipment as part of the system status panel. The mimic shall depict a complete single line diagram of the UPS and the following functions shall be lit with LED indicators.

(a) A.C. input power on;

(b) UPS on battery;

(c) Inverter ON;

(d) Static Bypass ON and healthy;

(e) Load supplied from Inverter and

(f) Load supplied from Static Bypass UPS.

(4) Potential Free Contacts

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

(a) Low Battery (pre alarm)

(b) Load on Inverter

(c) Load on Bypass

(d) Load on Manual Bypass

(e) Bypass failure.

(5) **Local Monitoring of UPS**

RS485 / Modbus connection should be available from each UPS for local monitoring. The contractor shall submit detailed list of Alarms/Parameters to be locally monitored for review and approval by the engineer.

(6) **Comprehensive Remote Monitoring**

(a) UPS System (i.e. individual UPS Modules and ATS) should be connectible to the TCP/IP based LAN Network through 3 Nos. dedicated LAN Ports in each UPS room and 1 No. dedicated LAN Port in the OCC. The detailed status/alarms should be available in the OCC and other terminals as per details given in TMS Technical Specification. Further, all necessary Software shall be provided and installed so as to see comprehensive data from all the Stations, Interlocking structures, OCC etc.

(b) Further, the contractor shall submit comprehensive remote monitoring philosophy for approval of the Engineer.

10. Environment

The UPS shall be designed for smooth continuous operation in the environment where it is installed. Alternatively, suitable Environment control measures shall be provided to maintain the environment within the design parameters.

11. Surge Suppression

(1) Critical and expensive electronic equipment should be protected from transient over-voltages by Transient Voltage Surge Suppressor. TVSS shall be put at the Input of each UPS and Bypass Stabilizer

(2) **The TVSS shall mee**t **following** primary **requirements.**

Surge Current Capacity	:	25kA for 6 KVA UPS System, 50kA for 30 KVA UPS System, 100kA for 60 KVA UPS System, 160kA for 120 KVA UPS
Fault Current Capability	:	> 12KA I/C
Connection Type	:	Parallel
Fusing	:	Individual Fusing of MOV's including N-G
Enclosure	:	NEMA Tested
Mounting	:	Wall Mounting or within Panel itself.

(3) **TVSS - Detailed Specifications**

(a) TVSS shall be provided at the Input of each UPS and bypass Stabilizer and electrically located at the respective outgoing feeders in the Input Transformer Cubicle. Further TVSS shall be provided at each Outgoing Feeder of the UPS Output AC Distribution Panel. The ratings of the TVSS will be subject to approval.

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

(c) The surge protective devices shall be sized as per IEEE Std C62.41-1991

and IEEE Std C62.45-1992.

(d) Surge protective devices used for three-phase, four-wire circuits shall be connected in all combinations of line-to-line, line-to-neutral, line-to-ground, and neutral-to-ground. (L-L, L-N, L-G, N-G). Devices used for single-phase, three-wire circuits shall be connected in all combinations of line-to-neutral and neutral-to-ground.(L-N, N-G).

(e) The TVSS shall have a UL 1listing and labelled 1449-3 suppressed voltage rating of 800V peak.

(f) The unit shall have a maximum continuous operating voltage (MCOV) rating of minimum 320VRMS.

(g) The Response time of TVSS shall be <= 0.5 nanoseconds.

(h) The TVSS shall provide up to 40dB for RFI & EMI noise attenuation.

(i) TVSS monitoring shall consist of indicator lamps and form C dry contacts.

(j) Monitoring of all modes, including N-E is required.

12. External Static Transfer Switch

(1) This intelligent static transfer switch shall ensure instantaneous transfer of load between the two power sources (Buses). A static bypass transfer switch Module shall be provided as free standing cabinet. This will consist of two sets of 100% rated Static Switches – one for Source -1 and the other for Source -2.

(2) The control unit shall contain an automatic transfer circuit that senses the status of both sources and alarm conditions to provide an uninterrupted transfer of the load without exceeding the transient limits specified herein. The smart control shall enable user to select the priority of source. Transfer time shall be adjustable with sensitivity control.

(3) The static bypass transfer switch shall be a fully Solid State static switch having anti-parallel SCR's that has a maximum transfer time of less than 4 millisecond in Synchronised condition and less than 20 Millisecond in Unsynchronised condition. The static switch shall be capable of supplying 110% rated current for 60 minutes, 150% for 60 seconds and 1,000 % for 10 M.Sc.

(4) The control panel shall Display status of incoming power source and the condition of static switch. Static Transfer Switch status shall be monitored through remote monitoring using RS 485 / MODBUS protocol. Minimum rating of 3 – phase switch shall be of 60 Amp.

13. System Expansion

The UPS and Battery Backup system shall be designed and equipped with all necessary hardware, software and capacity for future 20% additional load.

14. Testing and Inspection

The UPS Systems shall be offered for Factory Acceptance Tests as specified in GS/PS. During Inspection, following Tests, but not limited to, will be witnessed:-

(1) 8 Hour Heat Run Test of UPS Module at full load and normal temperature.

(2) Regulation Test.

(3) Test of Parallel Operation & current sharing of UPS Systems.

(4) Transfer and retransfer Checks.

(5) Synchronization test.

(6) Overload capability test.

(7) Short circuit capability test.

(8) UPS efficiency Tests.

(9) Tests for performance of operating parameters and controls.

(10) Tests for various Alarm levels.

(11) Battery Capacity/Backup Test (at Battery manufacturer's works).

(12) Review of test reports for SCVS, Input Isolation Transformer and ACDB and

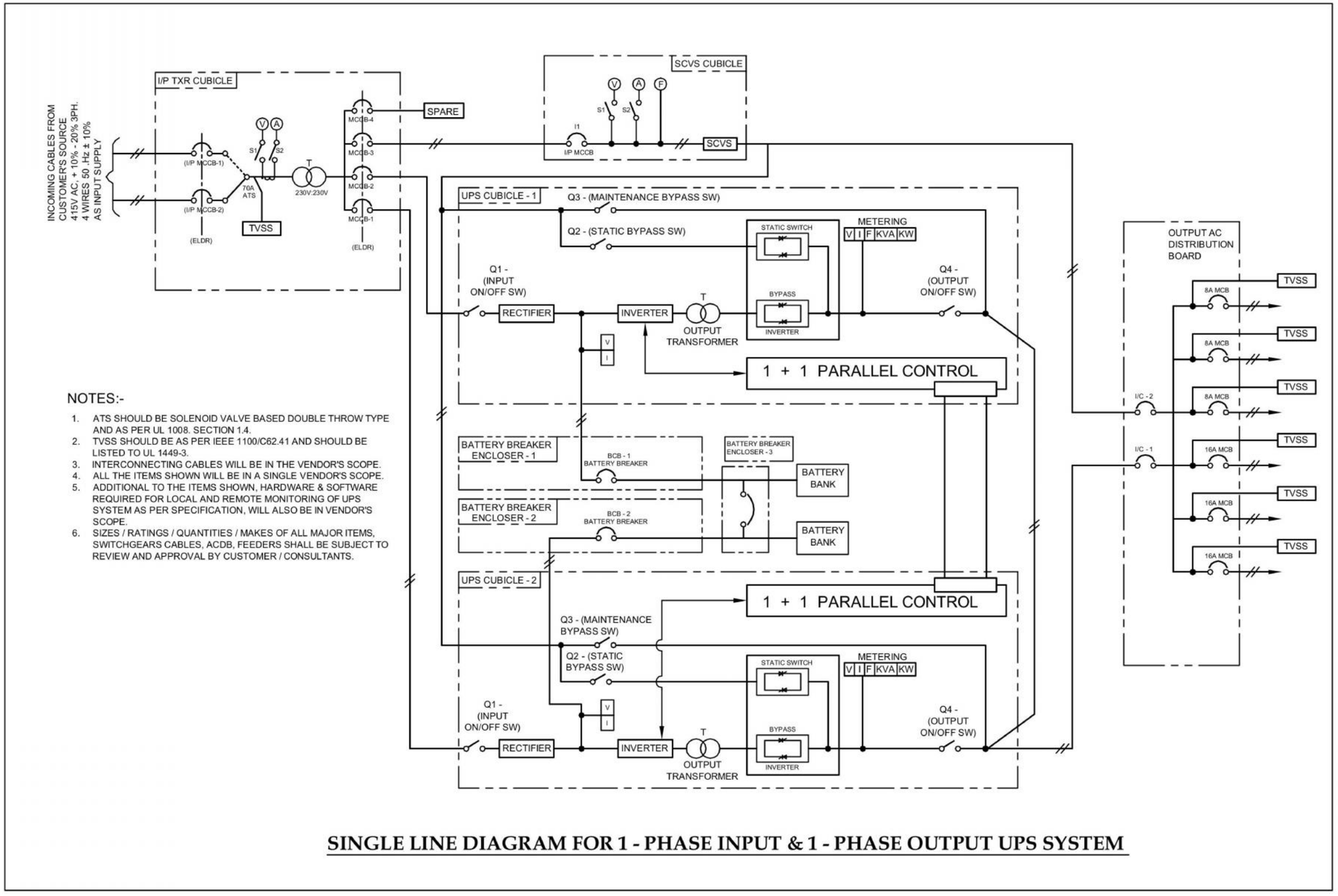
(13) Review of UL 1449-3 Listing Certificate for the TVSS selected.

(14) The battery discharge test shall be performed at a current corresponding to the inverter input current when the inverter is delivering its rated output full KW rating (i.e, KVA x 0.8 p.f.).

(15) The complete test schedule shall be as in standard formats of the vendor duly approved by the Engineer.

(16) Vendor shall submit and get approval of the required drawings before call for inspection is given.

Annexure I of Appendix 2

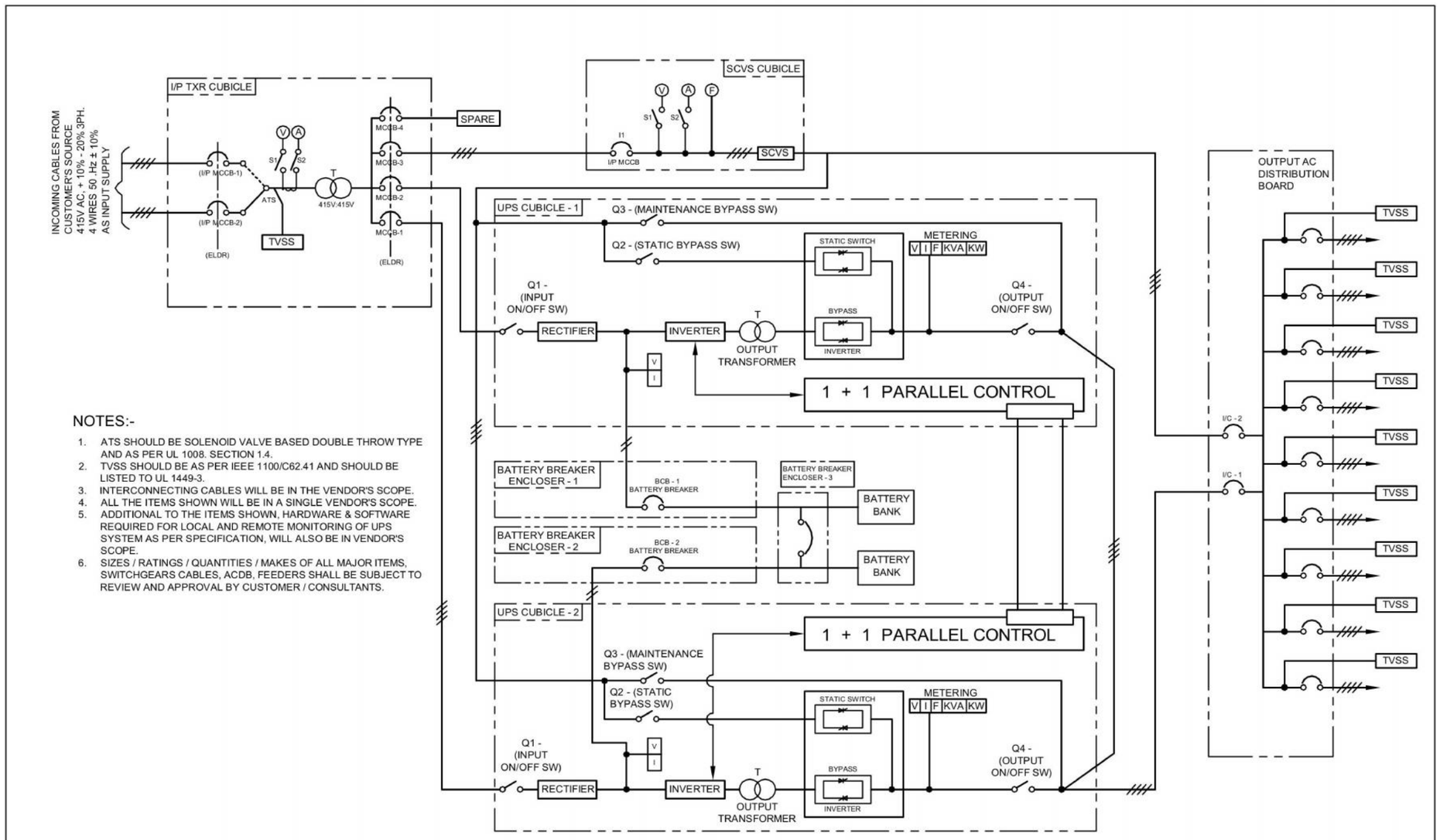


NOTES:-

1. ATS SHOULD BE SOLENOID VALVE BASED DOUBLE THROW TYPE AND AS PER UL 1008. SECTION 1.4.
2. TVSS SHOULD BE AS PER IEEE 1100/C62.41 AND SHOULD BE LISTED TO UL 1449-3.
3. INTERCONNECTING CABLES WILL BE IN THE VENDOR'S SCOPE.
4. ALL THE ITEMS SHOWN WILL BE IN A SINGLE VENDOR'S SCOPE.
5. ADDITIONAL TO THE ITEMS SHOWN, HARDWARE & SOFTWARE REQUIRED FOR LOCAL AND REMOTE MONITORING OF UPS SYSTEM AS PER SPECIFICATION, WILL ALSO BE IN VENDOR'S SCOPE.
6. SIZES / RATINGS / QUANTITIES / MAKES OF ALL MAJOR ITEMS, SWITCHGEARS CABLES, ACDB, FEEDERS SHALL BE SUBJECT TO REVIEW AND APPROVAL BY CUSTOMER / CONSULTANTS.

SINGLE LINE DIAGRAM FOR 1 - PHASE INPUT & 1 - PHASE OUTPUT UPS SYSTEM

Annexure II of Appendix 2



NOTES:-

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6. SIZES / RATINGS / QUANTITIES / MAKES OF ALL MAJOR ITEMS, SWITCHGEARS CABLES, ACDB, FEEDERS SHALL BE SUBJECT TO REVIEW AND APPROVAL BY CUSTOMER / CONSULTANTS.

SINGLE LINE DIAGRAM FOR 3 - PHASE INPUT & 3 - PHASE OUTPUT UPS SYSTEM

Appendix 3

Procedure Order For Cross Acceptance/Approval of Software Embedded Electronics Systems and New/Imported Technology Products for Railway Signalling for DFCCIL

(NOTE: These are general guidelines for DFCCIL. As there are no STEP items to be supplied in this work, the guidelines are applicable, if required, only for supply of Electronic Interlocking and Digital Axle counters)

1. Preface

(a) These guidelines are meant for evaluating software embedded electronic systems and new/imported technology products for Railway Signalling, which are already in use on a passenger carrying service anywhere in the world at speed more than 100KMPH, for adoption on DFCCIL using the concept of cross acceptance/cross approval. The procedure outlined in relevant CENELEC or any other equivalent standards to define and verify the safety requirements form the basis of these guidelines.

(b) These guidelines are applicable for evaluation of equipment against valid Contract Agreement with DFCCIL. These guidelines are to be applied as per requirement of respective Contract Agreement.

(c) These guidelines do not absolve the Contractor of his overall responsibility towards the relevant contract(s) in any manner whatsoever.

2. Object

The object of these guidelines is to outline the process, activities, responsibilities and documentation necessary to carry out the Cross Acceptance / Cross Approval exercise by DFCCIL.

3. Responsibility of Safety Assurance

(a) Safety clearance shall be given adopting the guidelines pertaining to Cross Acceptance/Cross Approval for adoption on DFC. This will include the System Hardware & Software Platform, Application software for implementing Safety Functions, Communication Interfaces, Input/output modules, Power Supply (vital) Systems & other related equipment.

(b) This approval for a particular product/system will be requested by the manufacturer of the system, through the Contractor. The manufacturer will be responsible for submission & authenticity of the documentation. The documentation should be as per procedure laid down.

4. Applications

These guidelines shall be applied for evaluation & acceptance of all Software Embedded Electronic Safely Systems and New/Imported Technology Products for Railway Signalling for provision on DFC.

The Electronic systems/products are as under:

(a) Electronic interlocking, Digital Axle Counters and Train Protection and Warning System

(b) STEP items to be supplied on account of STEP loan conditions.

5. Procedure

(a) DFCCIL shall appoint an ISA for safety assessment of the equipment.

(b) Contractor of the project shall ensure that manufacturer extends complete cooperation to DFCCIL/ISA/PMC.

(c) Manufacturer shall depute his technical personnel for technical clarifications when required by DFCCIL/ISA/PMC.

(d) The manufacturer/firm shall submit a Safety Plan to DFCCIL/ISA/PMC for evaluation of the System/equipment for Cross Acceptance/Approval. All documents shall be prepared in English language, checked & verified & marked appropriately indicating their version number, no. of alterations, etc.

(i) Safety plan shall be prepared and submitted. This will include:-

(1) System description which includes the system architecture/ configuration, system design & safety principle adopted for hardware & software.

(2) Safety Integrity Level of the system

(3) Safety case

(ii) Manufacturer shall check and verify that the system being offered meets the requirement of safety integrity laid down in the specifications.

(iii) Safety Case is documentary evidence that the safety system is conforming to and complies with the laid down safety requirements for it. Safety Case will have to be prepared in accordance with relevant CENELEC or equivalent standards & submitted to DFCCIL/ISA/PMC as the case may be for assessment. Safety case shall consist of the following documents:

(1) Details of approval given by an authority responsible for clearing safety system for use on a passenger carrying service at speed of more than 100 KMPH anywhere in the world.

(2) Standards to which the equipment have been developed and proposed to be supplied, i.e., CENELEC standard or any other equivalent standard adopted by that passenger-carrying Railway.

(3) Details of agencies, which have done software/hardware validations.

(4) Criteria adopted and assumption made.

(5) Documentation of these approvals, including trials, tests & measurements and simulation carried out.

(6) Restrictions, precautions, conditions or limitations imposed while giving clearance and thereafter action taken by the manufacturer.

(7) Calculations of Hazard rate or rate of unsafe side failure.

(8) Details/documents related to installation, functional operation, maintenance & modifications. Part list, wiring diagram, cable requirement, and list of tools and measuring equipment along with specification shall be given.

(9) Performance feedback duly authenticated and certified by various user Railways.

(10) Name, Designation, Phone & FAX Nos. and address of the official certifying the performance feedback should be clearly available. This will include Mean Time

Between Failures (MTBF) and Mean Time Between Wrong Side Failures (MTBWSF) and Mean Time To Repair (MTTR) figures as per format given in Annexure 'A'.

(11) Software & related instructions to configure the system initially as well as later due to changes in yard layout.

(12) Complete history of development of the equipment shall be given. Modifications carried out in the system, if any, during last five years shall be listed. Date of each modification with brief reasons for undertaking modification and whether modification has got approval of original validation/approving agency. Version No. allotted after each modification shall be mentioned.

(13) Type test (if required), Routine tests (which must be carried out on each equipment by the manufacturer) and acceptance tests (which are to be carried out on the equipment in the firm's premises before delivery) formats with test procedures and its significance for safety/reliability assessment of equipment. Sample routine test report/type test report/ factory acceptance test reports shall be submitted

(14) Details of climatic/EMI (Electro Magnetic Interference)/EMC (Electro Magnetic Compatibility) tests undergone by the equipment. Test reports of an accredited test laboratory (third party) shall be submitted. (The equipment shall also be subjected to environmental tests as per specification if not already done by some other reputed agency to the specified severity).

(15) Clause wise compliance statement to the specification and

(16) statement whether system is suitable for DFC application or will require modifications. Updated history of application has to be submitted in the format as per Annexure 'B' for use in passenger carrying service at speeds of more than 100 kmph.

(e) The Safety Integrity Requirement/Level for all vital applications for LC gates, station & Block Signalling & Interlocking systems / equipment / Track Circuits to be used on DFC, shall be SIL-4. In case, any system is required to have a SIL other than Safety Integrity Level-4 (SIL-4), DFCCIL approval shall be obtained before evaluating the system for Cross Acceptance.

(f) The evaluation for Cross Acceptance shall normally be in compliance to the relevant specifications.

(g) Provenness criteria of equipment usage of same Type/Make & Model/Version shall be as under: -

S No.	**Category of Equipment/System**	**Minimum number of Equipment**	**Equipment Hours in use**
1.	Digital Axle Counter	50	4,32,000
2.	TPWS (i) On Board Equipment (ii) Track Equipment Balise	25 100	2,16,000 8,64,000
3.	Electronic Interlocking	25	2,16,000
4.	Other items	100	8,64,000

Note 1: For all the above items: At least 20% of the equipment/system, with a minimum of 10, should be in continuous operation for a minimum period of 720 days.

Note 2: If the offered equipment has undergone minor hardware/software upgradation to improve functionality/safety of the equipment in recent past, then the equipment utilisation of the earlier version (prior to minor modifications) can be considered for the provenness. This decision of considering the earlier version for provenness shall be taken by DFCCIL. However, in such cases, a minimum of 10 (Ten) upgraded equipment should be in continuous operation for a minimum period of 180 days. Field trial of the equipment shall be conducted as detailed at Annexure C.

Note 3: STEP items to be supplied, as part of tied Japanese loan, if not deployed for commercial service anywhere, shall be subjected to type test and field trial as detailed at Annexure 'C'.

(a) The manufacturer shall have adequate skilled and trained manpower with good expertise in relevant fields of manufacturing, installation, training, maintenance support etc. Details of these personnel with name, educational qualification, training undergone & experience shall be furnished at the time of approval.

(b) Manufacturer seeking approval shall guarantee for supply of spares during life of the equipment & extend maintenance support**.**

(c) The firm shall provide all necessary test facilities to DFCCIL representative in their premises in India and abroad as prescribed by their principals at the time of approval.

(d) DFCCIL/ISA/PMC shall assess the safety case & prepare the assessment report clearly recommending whether the system/equipment is permitted for:-

  (i) Type test and trials

  (ii) Field trials

  (iii) Use on DFC

(e) The type tests and field trials, as required, shall be conducted as per Annexure "C'. After DFCCIL/ISA/PMC is satisfied with the documents submitted by the firm; results of the type test and field trial, if any; approval for the particular contract shall be given.

(f) If any document of safety case is withdrawn or if any problem with the product arises, the supplier shall inform DFCCIL immediately. In such or any similar case DFCCIL may modify/withdraw the approval, as required

Annexure 'A' of Appendix-3

Format for Performance Feedback

1. Name of System/Equipment :
2. Make :
3. Model/Version No. :
4. User Railway & Section :
5. Maximum Sectional Speed :
6. Arrange number of Trains per day :
7. Application of System/Equipment :
8. Problems faced and solutions evolved :
9. Failure data may be submitted as per format given below :

Location	No. of System / Eqpt.	Date of commi-ssioning	Total hours in use	No. of safe side failures	No. of unsafe failures	MTBF	MTBWSF	MTTR
Total								

Annexure 'B' of Appendix-3

Format for History of Application

Sl NO	Hardware version No.	Software version No.	Model No.	User Rly.	Station/ Section	No. of Eqpts. In use	In use from date

Annexure 'C' of Appendix-3

Type test for Signalling items

In case DFCCIL is fully satisfied with the consolidated report of the assessment, approval shall be given for type testing of prototype sample.

1. The type testing of prototype sample shall be undertaken to the satisfaction of DFCCIL.

2. Type tests shall be carried out on specific items to ensure that they perform their intended functions when subjected to all permutations and combinations of external environment and other factors.

3. The following tests shall constitute type tests :

   (i) Visual inspection tests
   (ii) Insulation resistance tests
   (iii) Card level functional and fail safety tests
   (iv) System level functional and fail safety tests
   (v) Computerized testing
   (vi) EMI/EMC tests
   (vii) Environmental / Climatic Tests
   (viii) System Diagnostic Tests
   (ix) System Software Test
   (x) Any other test deemed necessary

4. Manufacturer shall submit a comprehensive type test plan including procedure, type test format and expected results. The type test plan shall be finalized in consultation with DFCCIL / ISA / PMC.
5. Type tests shall be carried out at manufacturer's premises. Necessary testing equipment and competent man power shall be made available by the manufacturer.
6. Type test shall be carried out by DFCCIL representative / ISA.
7. Tests which cannot be carried out in house may be referred to independent test house of repute.
8. EMC / EMI tests may not be required if previous independent witness tests have been successfully carried out and reported by document.

Field trials for Signalling items

1. The field trials shall be conducted to the satisfaction of the DFCCIL.
2. The field trials shall be held on Indian Railways / DFC as decided by DFCCIL. DFCCIL shall coordinate with IR for this purpose.
3. The Contractor / Manufacturer shall make all arrangements for conducting field trials. This shall include; but not limited to; supply, installation, commissioning and monitoring of the equipment.
4. The trials shall be monitored in the following manner –

S N	Name of Division / Railway / Section	Name of station	Model and version no.	Date of installation	No. of failures*	Remarks

* Analysis of cause of failures to be attached.

Duration of field trial

SN	Item / Equipment	Initial trial	
		Number of equipment	Duration
1.	EI	01	180 days in parallel and/or standalone mode or a combination thereof as decided by DFCCIL
2.	DAC	01	180 days in parallel and/or standalone mode or a combination thereof as decided by DFCCIL
3.	TPWS	One (01) set of on Board equipment and ten (10) sets of track side system shall be installed and detailed trials shall be conducted for 180 days for compliance to specifications and performance monitoring.	

NOTE:

1. The number of equipment and duration can be suitably revised, as required, by DFCCIL.
2. DFCCIL shall decide if field trials and type test can proceed simultaneously or not.

(End of Appendix 3)

Appendix 4

Drawings for Cable Laying

S. No.	Description	Drawing No.	Annexure No. of Appendix 4
1.	Joint Procedure Order for undertaking digging work in the vicinity of underground Signalling, Electrical and Telecommunication cables		Annexure - I
2.	DFCC Cable laying in Station yard	GGM/Signal/Indicative Drawing No.:1	Annexure – II(a)
3.	DFCC Cable laying in Block Section	GGM/Signal/Indicative Drawing No.:2	Annexure – II(b)
4.	Cable trench	SDO/CABLE LAYING/003	Annexure - III
5.	Laying of cables in rocky area	SDO/CABLE LAYING/008	Annexure - IV
6.	Track crossing	SDO/CABLE LAYING/009	Annexure - V
7.	Road crossing	SDO/CABLE LAYING/010	Annexure - VI
8.	Cable laying on culverts with low flood level	SDO/CABLE LAYING/011	Annexure - VII
9.	Cable laying on culverts with high flood level	SDO/CABLE LAYING/012	Annexure - VIII
10.	Cable laying on metallic bridges	SDO/CABLE LAYING/013	Annexure - IX
11.	Cable Trough for metallic bridges	SDO/CABLE LAYING/014	Annexure - X

Note: The sketches' given are indicative. The detailed drawings shall be proposed by the Contractor and approved by the Engineer.

Annexure-I of Appendix 4

JPO No. 1/SG/2004

(Issued under CRB's letter No. 2004/Sig/G/7 dated 17.12.2004)

JOINT PROCEDURE ORDER FOR UNDERTAKING DIGGING WORK IN THE VICINITY OF UNDERGROUND SIGNALLING, ELECTRICAL AND TELECOMMUNICATION CABLES

A. A number of Engineering works in connection with gauge conversion/doubling/third line are in progress on various railways, which require extensive digging work near the running track, in close vicinity of the working S&T cables carrying vital safety circuits as well as electrical cables feeding the power supply to Cabins, ASM room, RRI Cabin, Intermediate Block Huts (IBH) etc. Similarly, S&T organization under open line or construction units under CAO/C are executing various signalling and telecommunication works requiring digging of earth for laying of cables or casting of foundations of the erection of signal posts etc. RailTel are also executing the work of laying of quad cable and OFC on various Railways as a part of sanctioned works for exclusive use of Railways for carrying voice and date i.e. administrative and control communication, PRS, FOIS etc. or shared by RailTel Corporation of India Ltd. On certain sections digging is also required for laying of electrical cable and casting of foundation for erection of OHE masts by Electrical Deptt. Generally, these works are executed by contractors employed by these organizations.

B. However, while carrying out these works in the vicinity of working signalling, telecommunication and electrical cables, at times, cable cuts take place due to JCB machines working along the track or during the digging work being done by Contractors carrying out the Civil Engineering Works. Similarly, such cable cuts are also resulting due to works undertaken by S&T or Electrical Deptts. Such Cable faults results in the failure of vital signalling and telecommunication circuits.

C. Henceforth, the following joint procedure shall be followed by Engineering, Electrical and S&T (and RailTel Organization, wherever such works are being done by them) Officers of the respective divisions and by the Construction Organization, while carrying out any digging work near to existing signalling & telecommunication and electrical cables, so that the instances of cable cut due to execution of works can be controlled and minimized.

(1) S&T Department (and RailTel, where they have laid the cables) & Electrical Deptts. shall provide a detailed cable route plan showing exact location of cable at an interval of 200m or wherever there is change in alignment so that the same is located easily by the engineering official/contractor. This cable route plans shall be made available to the DSE/DEN or Dy. CE/C as the case may be by Sr. DSTE/DSTE or Sr. DEE/DEE of the divisions or Dy. CSTE/C or Dy. CEE/C within a reasonable time in duplicate. DSE/DEN or Dy. CE/C will send copies to their field unit i.e. AEN/SE/P.Way & works.

(2) Before taking up any digging activity on a particular work by any agency, Sr. DSTE/DSTE or Sr. DEE/DEE of the section shall be approached in writing by the concerned Engg. or S&T or Electrical officer for permitting to undertake the work. After ensuring that the concerned executing agencies including the contractor have fully understood the S&T and Electrical cable route plan shall permit the work in writing.

(3) After getting the permission from S&T or Electrical Deptt. as the case may be, the relevant portion of the cable route plan shall be attached to the letter through which permission is issued to the contractor by concerned Engg. official for commencement of work and ensuring that the contractors have fully understood the cable route plan and precautions to be taken to prevent damage to the underground cables. The contractor shall be asked to study the cable plan and follow it meticulously to ensure that the safety of the cables not endangered. Such a provision, including any penalty for default, should form part of agreement also. It is advisable that a suitable post of SE (Sig) or SE (Tele) or SE (Elect) shall be created chargeable to the execution of the work. However basic responsibility will be of the Department executing the work and the Contractor.

(4) The SE (P.Way) or SE (Works) shall pass on the information to the concerned SE (Sig) or SE (Tele) or SE (Elect) about the works being taken up by the contractors in their sections at least 3 days in advance of the day of the work. In addition Engineering control shall also be informed by SE (P.Way) or SE (Works), which in turn shall pass on the information to the Test Room/Network Operation Centre of RailTel/TPC/Electrical Control.

(5) On receiving the above information, SE (Sig) or SE (Tele) or SE (Elect) shall visit the site on or before the date of taking up the work and issue permission to the contractor to commence the work after checking that adequate precautions have been taken to avoid the damage to the cables. The permission shall be granted within 3 days of submission of such requests.

(6) The name of the contractor, his contract telephone number, the nature of the work shall be notified in the Engineering Control as soon as the concerned Engg. official issued the letter authorizing commencement of work to the contractor. Test Room be given a copy and Test Room shall collect any further details from the Engineering Control and shall pass it on to S&T/RailTel & Elect. officials regularly.

(7) In case of works being taken up by the State Government, National Highway Authority etc., the details of the permission given i.e. the nature of work, kilometer etc. be given to the Engineering Control including the contact person's number so that the work can be done in a planned manner. The permission letter shall indicate the contact numbers of Test Room/Network Operations Centre of RailTel/TPE/Elect. Control.

(8) Where the nature of the work taken by the Engineering department is such that the OFC or other S&T cables or Electrical cables is to be shifted and relocated, notice of minimum one week shall be given so that the Division/RailTel/Construction can plan the works properly for shifting. Such shifting works shall, in addition, for security and integrity of the cables, be supervised by S&T Supervisors/RailTel Supervisors/Electrical Supervisors.

(9) The concerned SE(P.Way)/SE(Works)/SE(Sig)/SE(Tele)/SE(Elect.) or RailTel supervisors, supervising the work of the contractor shall ensure that the existing emergency sockets are not damaged in view of their importance in providing communication during accident/emergency.

(10) In case of minor nature of works where shifting of cable is not required, in order to prevent damage to the cable, the Engineering Contractor shall take out the S&T or optical fibre cable or Electrical cable carefully from the trench and place it properly

alongside at a safe location before starting the earthwork under the supervision of SE (Sig) or SE (Tele) or SE (Electrical). The cable shall be reburied soon after completion of excavation with proper care including placement of the brick over the cable by the concerned S&T Supervisors or Electrical Supervisors. However, the work will be charged to the concerned engineering work.

(11) In all the sections where major project are to be taken up/going on RailTel/S&T Deptt. shall deploy their official to take preventive/corrective action at site of work.

(12) No new OFC/Quad cable shall be laid close to existing track. It shall be laid close to Railway boundary as per extant instructions i.e. 1.0 m from the Railway boundary to the extent possible to avoid any interference with future works (doubling etc.). It shall be ensured in the new works of cable laying that the cable route is properly identified with electronic or Concrete markers. Henceforth, wherever cable laying is planned and before undertaking the laying work, the cable route plan of the same shall be got approved from the concerned Sr. DEN or Dy. CE/ Constn. to avoid possible damages in future. Such approvals shall be granted within 7 days of submission of the requests.

(13) The works of excavating the trench and laying of the cable should proceed in quick succession, leaving a minimum time between the two activities.

(14) Any damage caused to OFC/Quad cable or Electrical cable during execution of the work, necessary debit shall be raised on Engineering Department who shall bear the cost of the corrective action.

(15) All types of bonds i.e. rail bond, cross bond and structure bond shall be restored by the Contractor with a view to keep the rail voltage low to ensure safety of personnel.

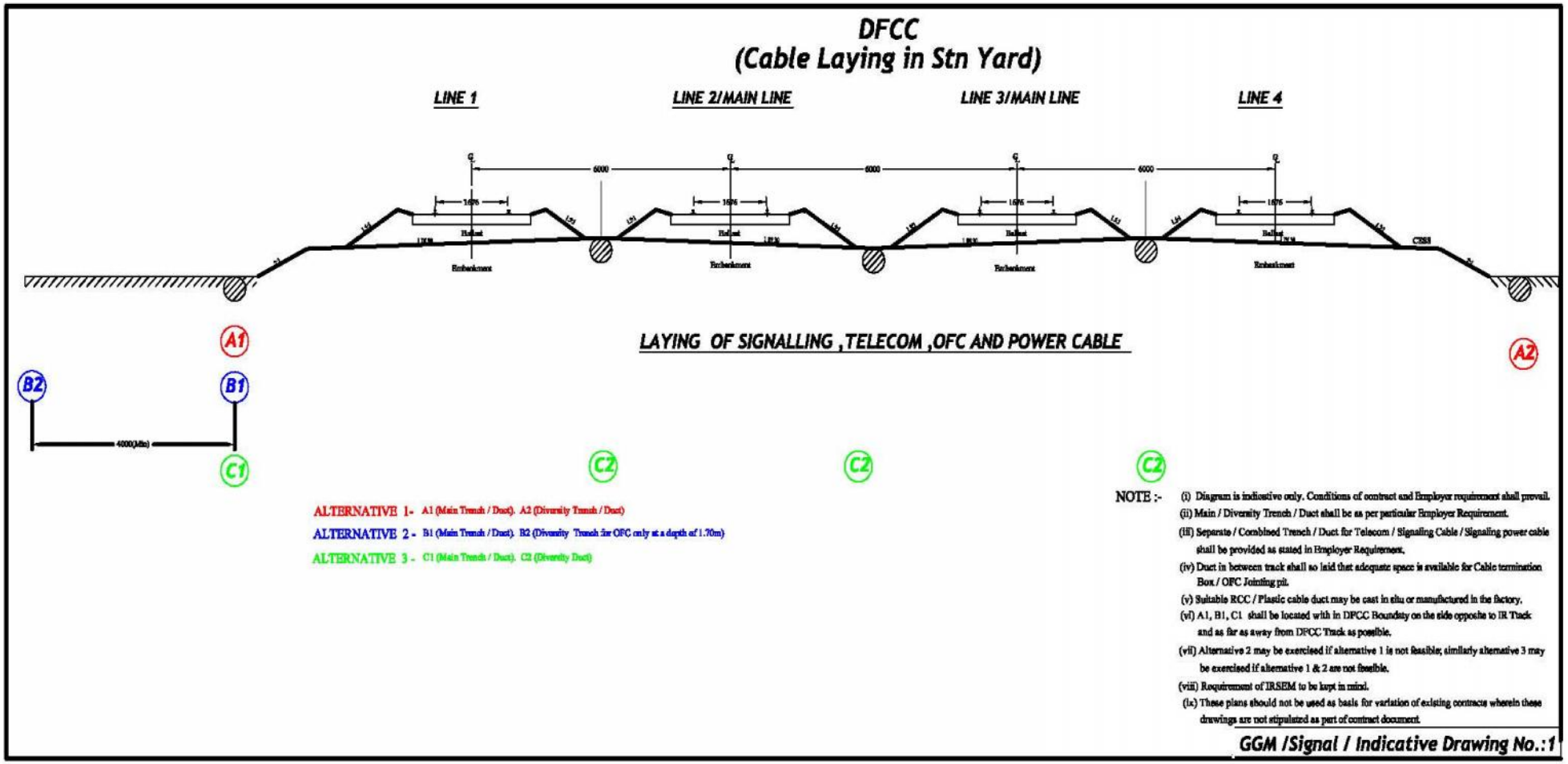
(16) Above joint circular shall be applicable for construction as well as open line organization of Engineering, S&T & Electrical.

(17) The S&T cable and Electrical cable route plan should be got approved from the concerned Sr. DSTE/DSTE & Sr. DEE/DEE respectively, before undertaking the work and completion cable route plan should be finalized Block section by Block section as soon as the work completed.

NOTE: Various designations mentioned in the above Joint Procedure Order are for Railways. In the DFCCIL work, all approvals/inspections will be by the Engineer rather than the designated officials mentioned in the above Joint Procedure Order.

End of Annexure I of Appendix 4

Annexure-II(a) of Appendix 4



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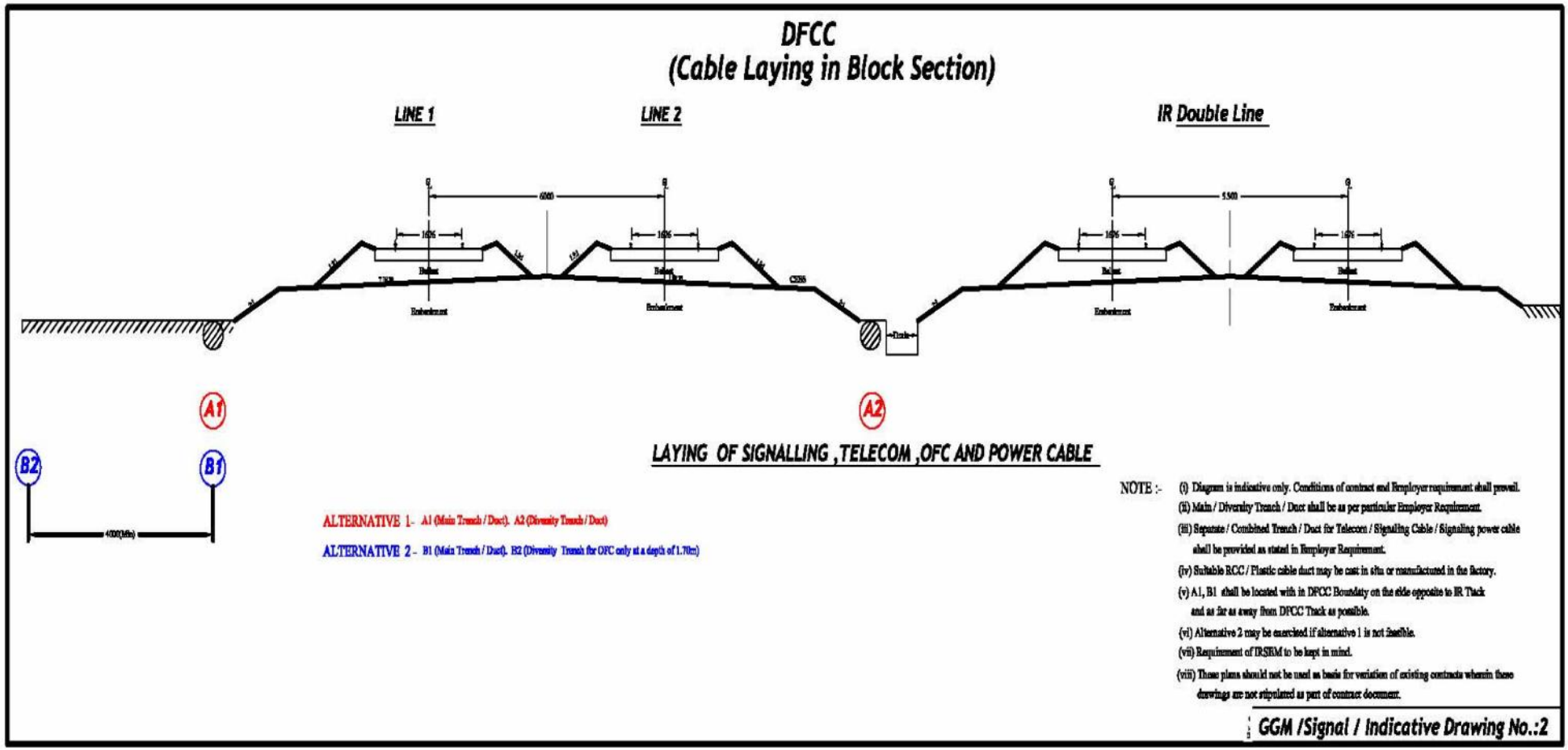

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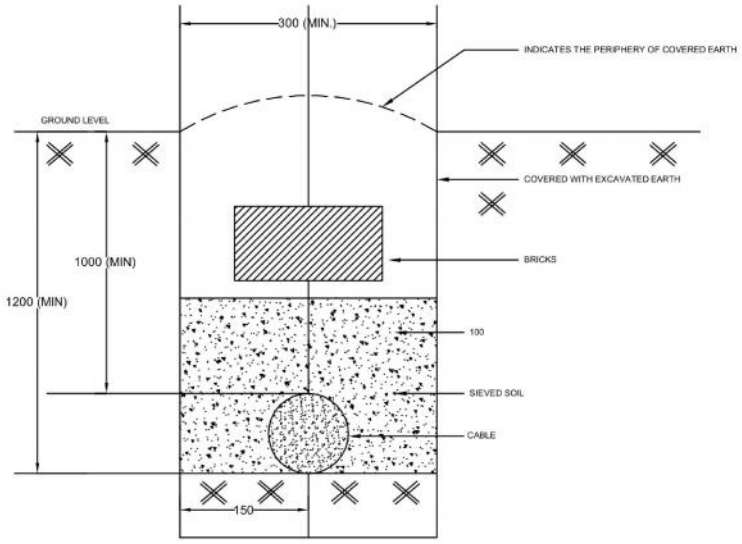

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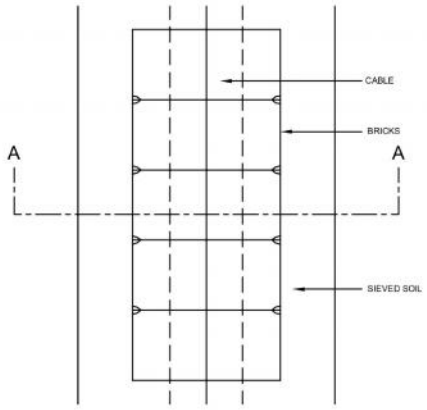
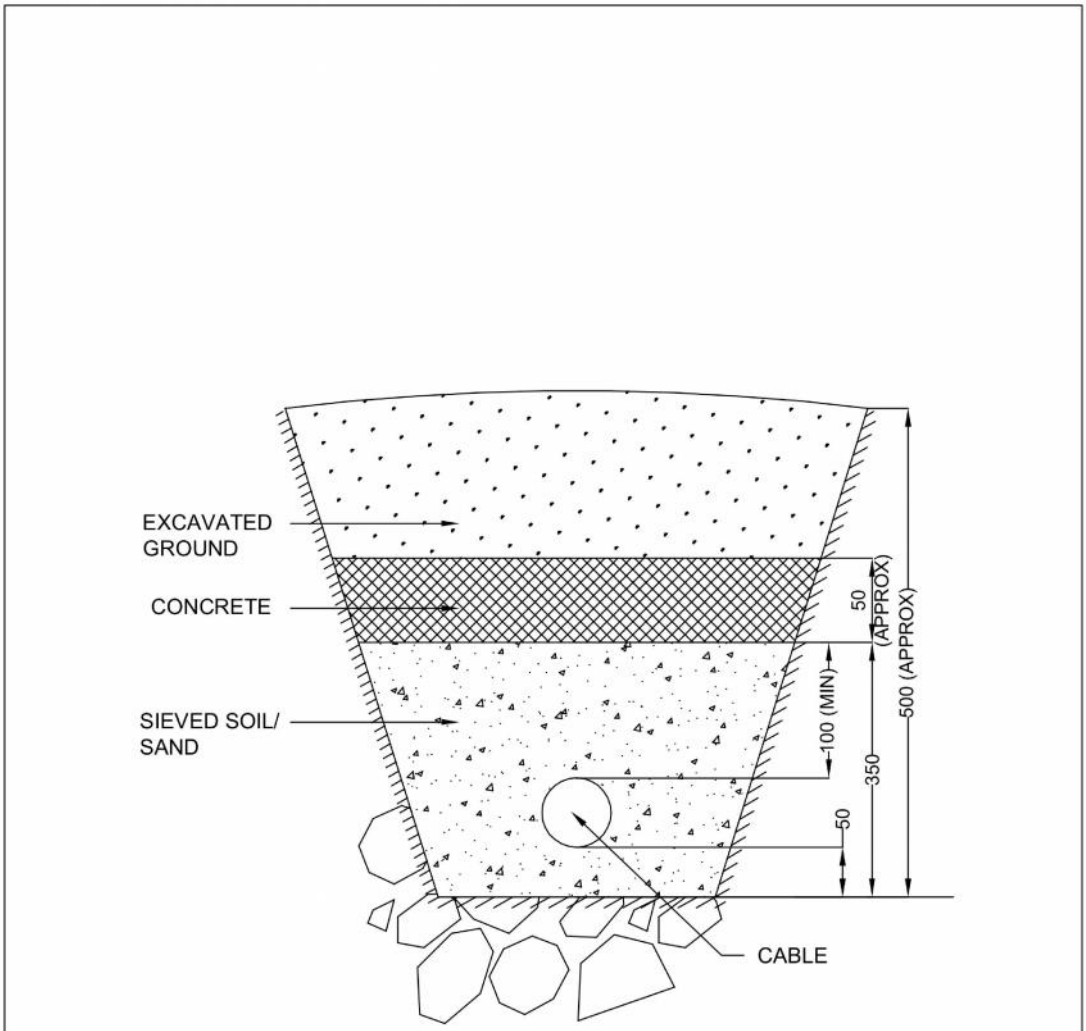


PLAN VIEW

NOTE:-
ALL DIMENSIONS ARE IN MILLIMETER.

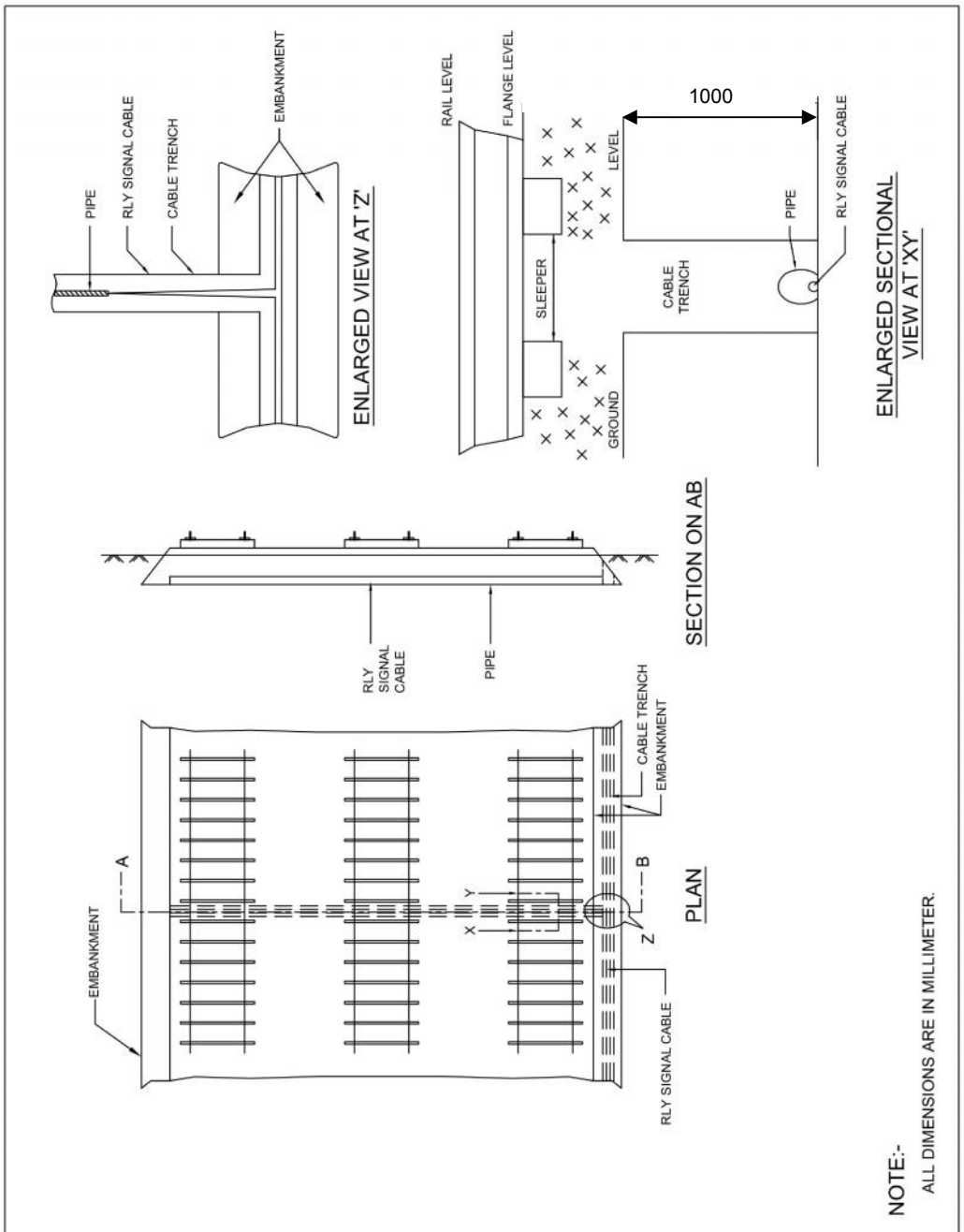
CHECKED BY	JE/SE/SSE	CABLE TRENCH	SDO/CABLE LAYING/003
APPROVED BY	ADE	RDSO	DATE : 31-10-2011
NOT TO SCALE			

Annexure-IV of Appendix 4



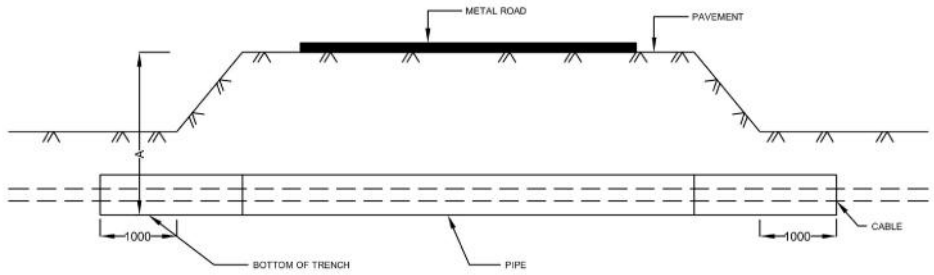
CHECKED BY	JE/SE/SSE	LAYING OF CABLES IN ROCKY AREA	SDO/CABLE LAYING/008
APPROVED BY	ADE	RDSO	DATE : 31-10-2011
NOT TO SCALE			

Annexure-V of Appendix 4



CHECKED BY	JE/SE/SSE	TRACK CROSSING	SDO/CABLE LAYING/009
APPROVED BY	ADE	RDSO	DATE : 31-10-2011
NOT TO SCALE			

Annexure-VI of Appendix 4



ALL DIMENSIONS ARE IN MILLIMETER.

CHECKED BY	JE/SE/SSE	ROAD CROSSING	SDO/CABLE LAYING/010
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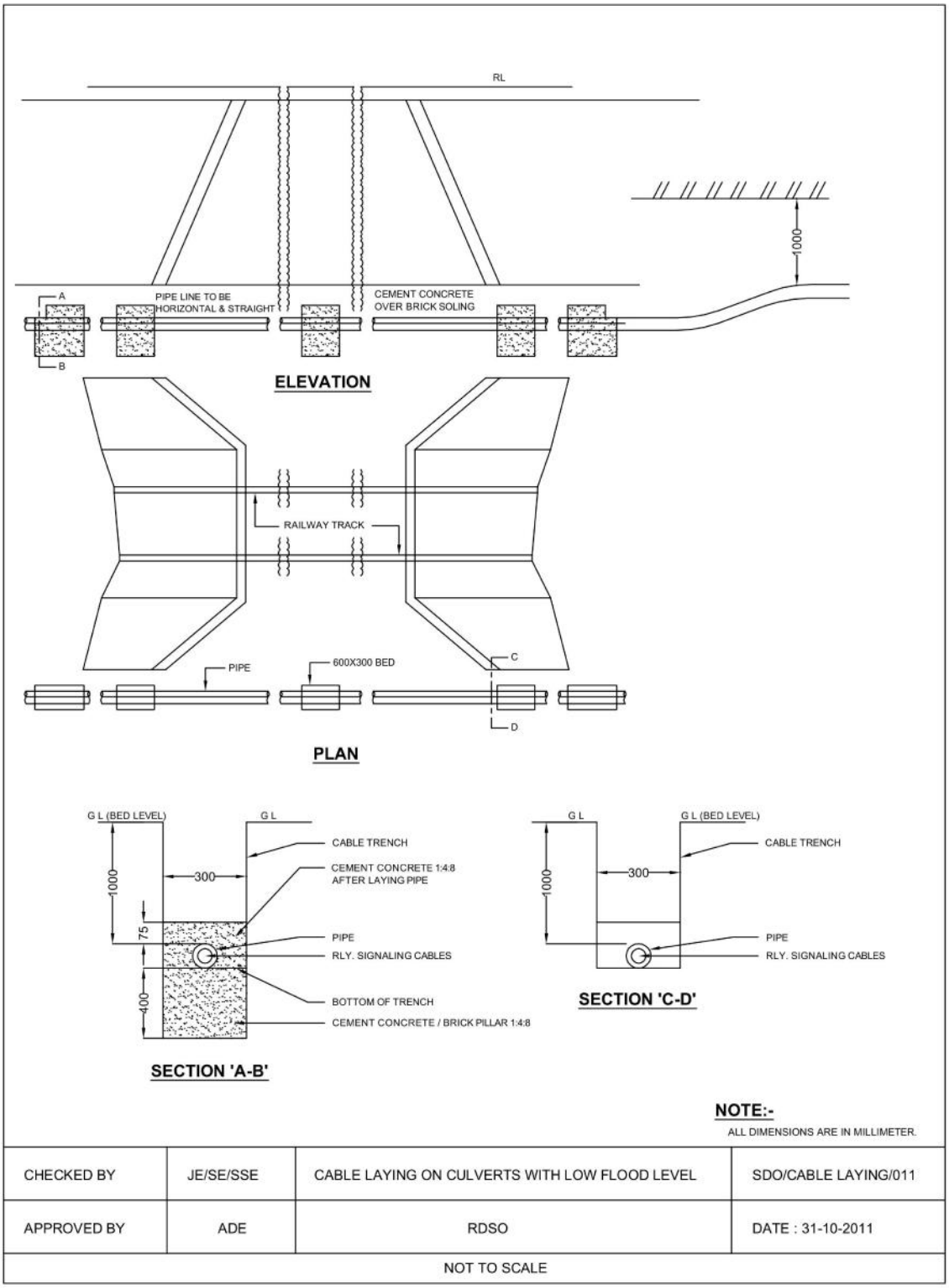
NOT TO SCALE			

Annexure-VII of Appendix 4



NOTE:-
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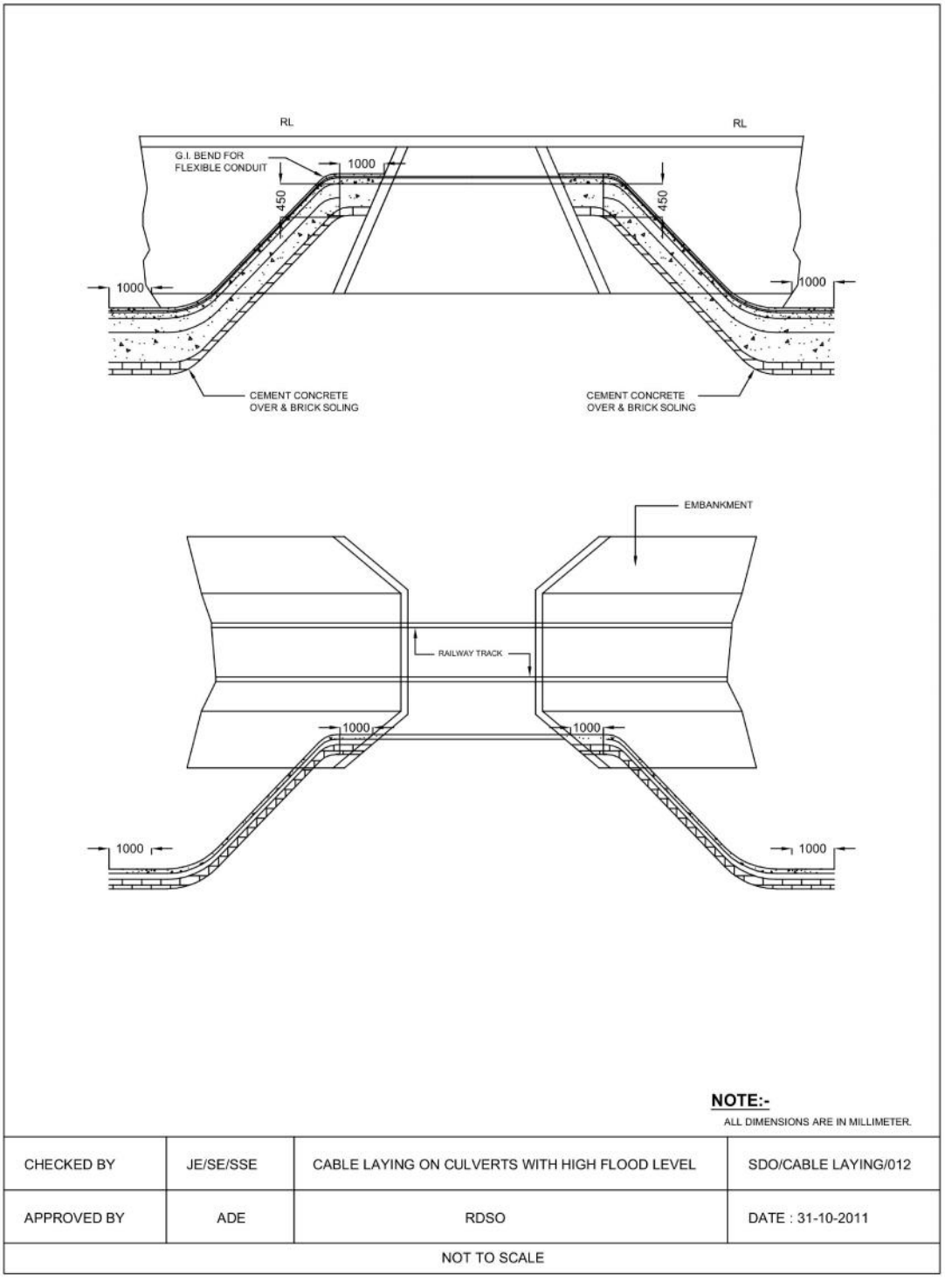
NOT TO SCALE			

Annexure-VIII of Appendix 4



NOTE:-
ALL DIMENSIONS ARE IN MILLIMETER.

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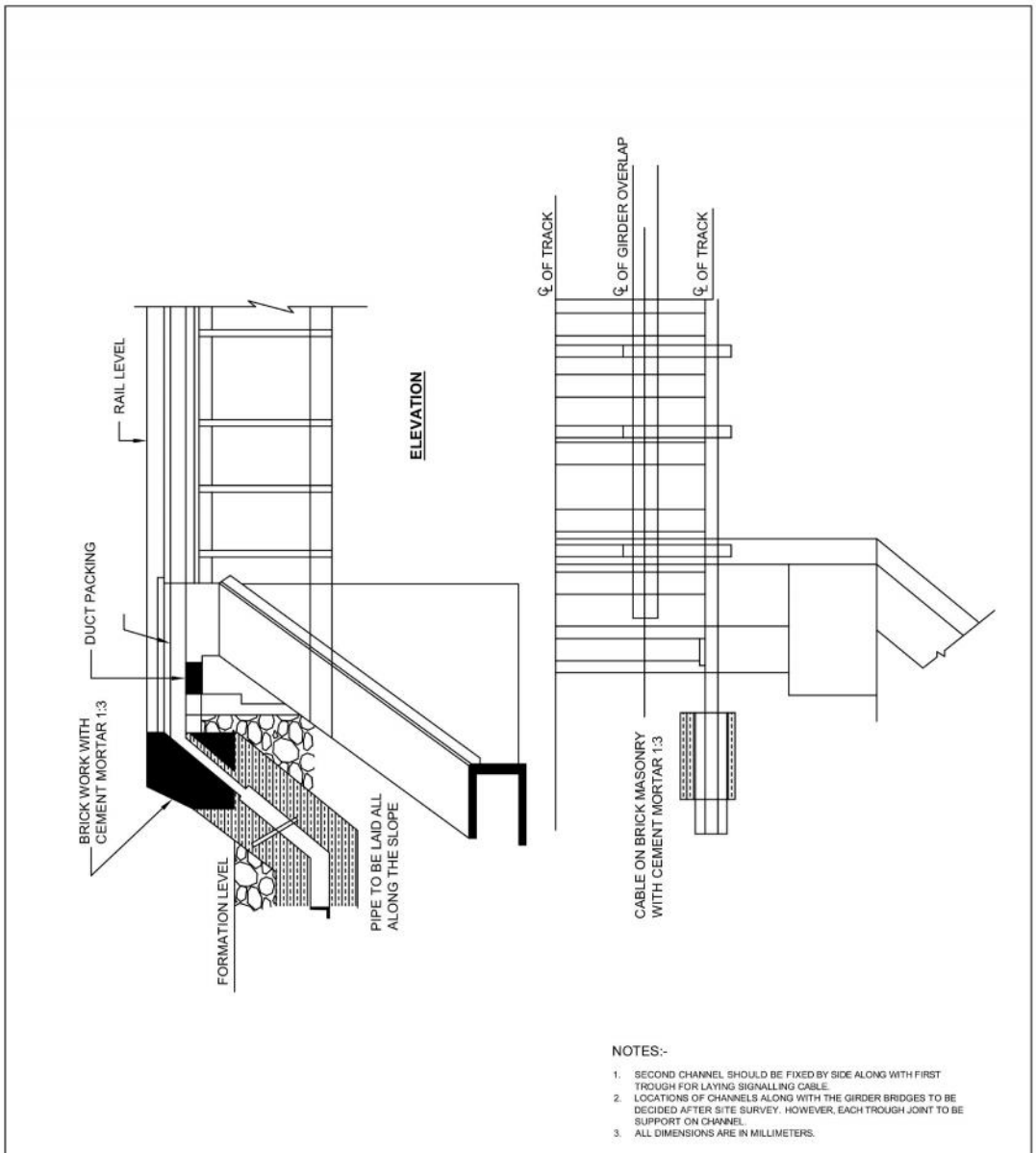
NOT TO SCALE			

Annexure-IX of Appendix 4



CHECKED BY	JE/SE/SSE	CABLE LAYING ON METALLIC BRIDGES	SDO/CABLE LAYING/013
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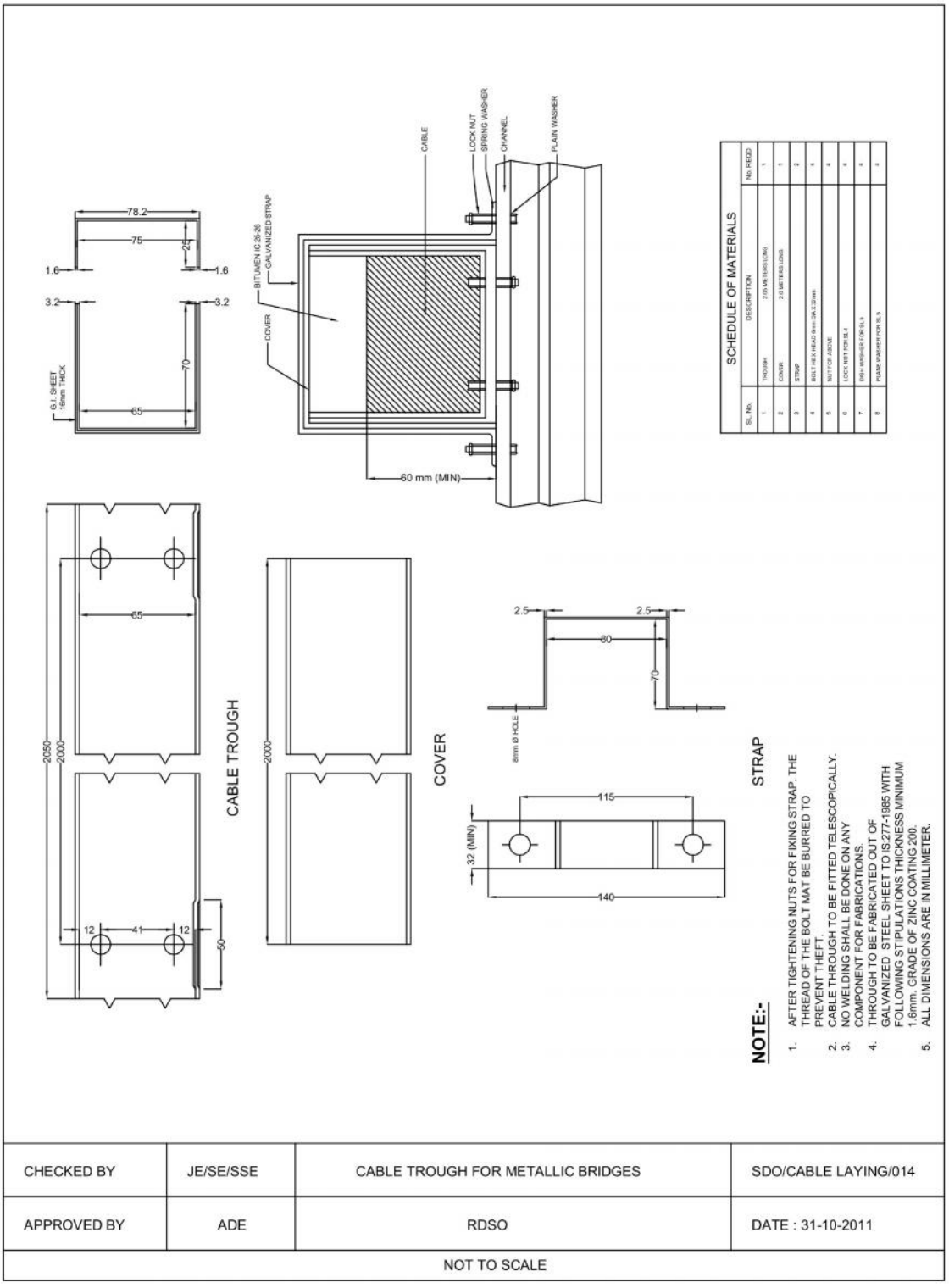
NOT TO SCALE			

Annexure-X of Appendix 4



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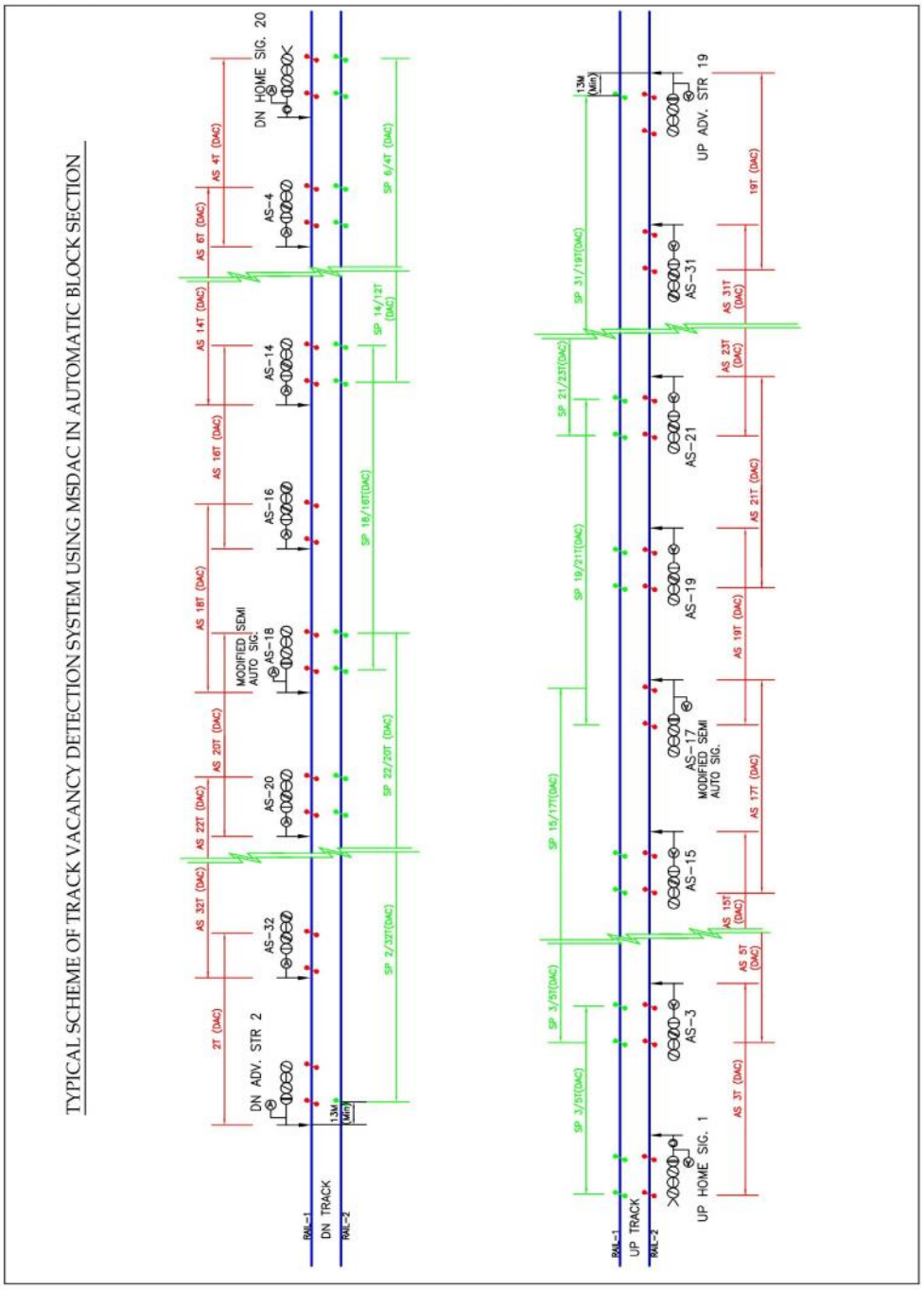
NOT TO SCALE			

Appendix 5

Typical Scheme of Track Vacancy Detection System Using MSDAC in Automatic Block Section



(End of Appendix 5)

Appendix 6

Earthing & Bonding Connections

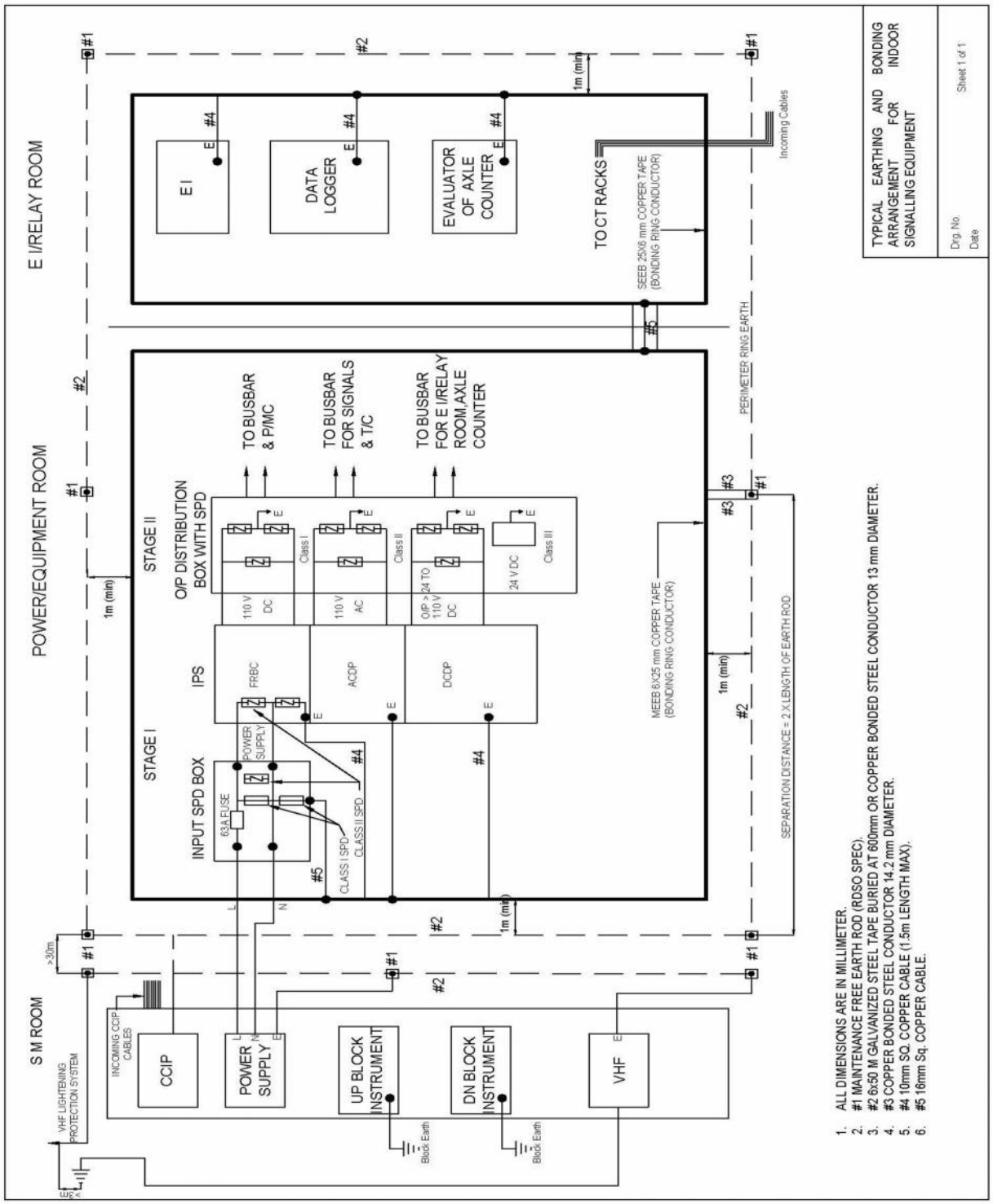
Earthing & Bonding connections Drawing for:

(1) Typical Earthing and Bonding arrangement for Indoor Signalling equipment - Annexure-I of Appendix 6

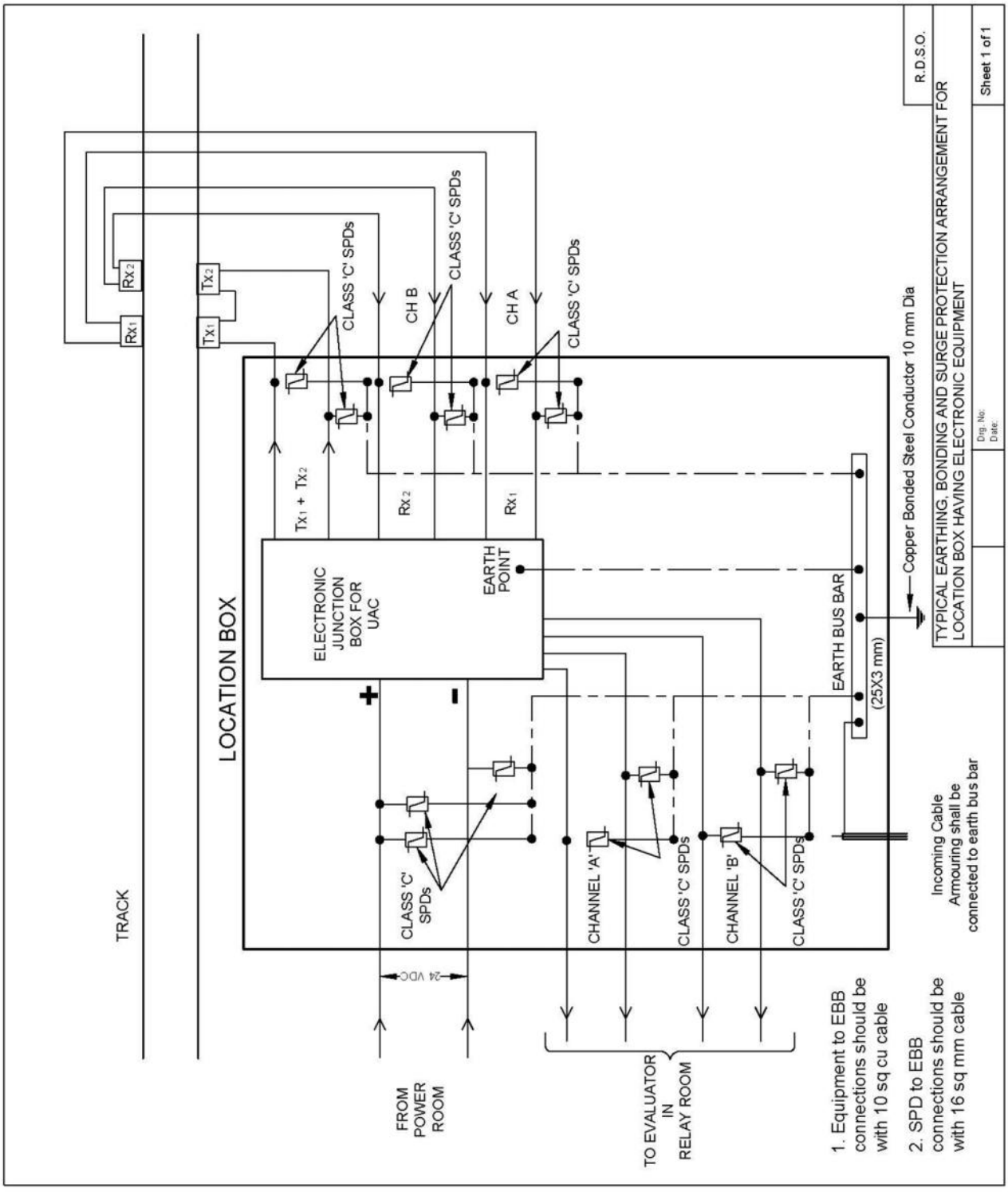
(2) Typical Earthing, Bonding and Surge Protection arrangement for Location Box having Electronic Equipment – Annexure-II of Appendix 6.

Note: The sketches' given are indicative. The detailed drawings shall be proposed by the Contractor and approved by the Engineer.

Annexure-I of Appendix 6



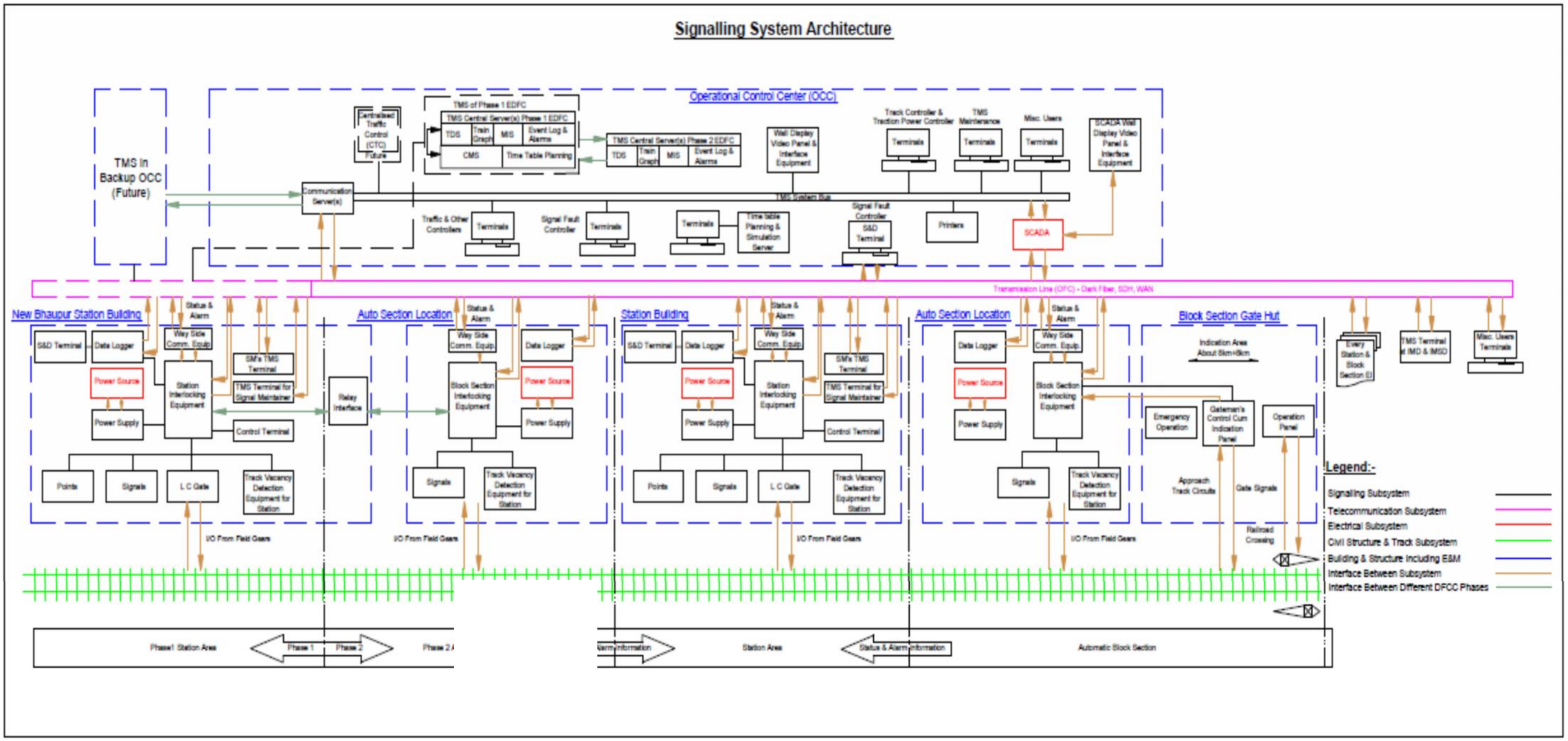
Annexure-II of Appendix 6



(End of Appendix 6)

Appendix 7

Signalling System Architecture



(End of Appendix 7)

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: CP-203

Issued on: **30-03-2015**

ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

Part 2, Section VI, Volume 3,

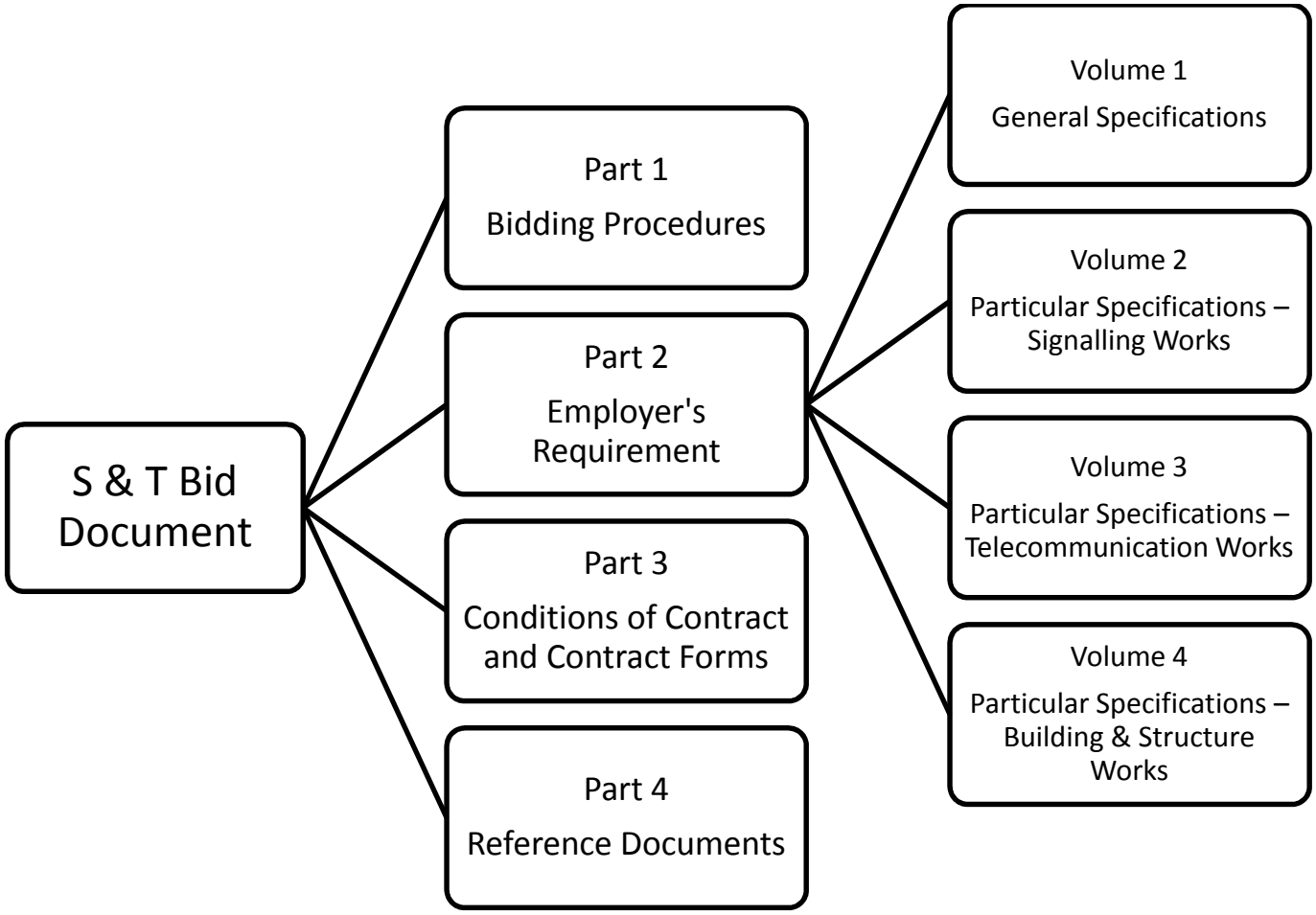
Particular Specifications

Telecommunication Works

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)

COUNTRY: **INDIA**

30.03.2015


S & T Bid Document
Part 1
Bidding Procedures
Part 2
Employer's Requirement
Part 3
Conditions of Contract and Contract Forms
Part 4
Reference Documents
Volume 1
General Specifications
Volume 2
Particular Specifications – Signalling Works
Volume 3
Particular Specifications – Telecommunication Works
Volume 4
Particular Specifications – Building & Structure Works

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CHAPTER 1 - INTRODUCTION

1.1 General

1.1.1 Phase-II of Eastern Dedicated Freight Corridor (hereinafter will be called EDFC Phase-II) Project is construction of 25 kV AC, AT Feeding, Electrified Double Track in Mughalsarai-New Bhaupur Section.

1.1.2 The EDFC Phase-II will have 7 Crossing Stations and 5 Junction Stations. The Junction Stations will be connected to IR stations through single line tracks. The trains from/to Indian Railways will enter/exit the EDFC Phase-II at these five Junction Stations. Details of these Crossing Stations and Junction Stations are given in General Specifications.

1.1.3 There will be 18 Level Crossings Gates in the EDFC Phase-II. These gates will be manned and interlocked & protected by Gate Signals. Details of these 18 Level Crossings Gates are given in General Specifications.

1.1.4 Control and Monitoring of Traction Power in the EDFC Phase-II shall be via a dedicated Supervisory Control and Data Acquisition (SCADA) System. Traction Power System includes Traction Sub-Station (TSS), Sectioning Post (SP) and Sub-sectioning Post (SSP). Details of these TSS, SP and SSP are given in General Specifications.

1.1.5 In EDFC Phase-II, Integrated Maintenance Depots(IMDs) have been planned at Mughalsarai, New Karchana and New Kanpur and Integrated Maintenance Sub Depots(IMSDs) have been planned at New Dagmagpur, New Unchdih, New Manauri, New Rasulabad and New Malwan stations. These depots will have maintenance facilities for all the concerned departments viz. Electrical, Civil, Signalling and Telecommunication.

1.1.6 In EDFC Phase-II, residential complexes have been planned for its staff. A total no. Of 263 Residential Quarter/Houses shall be constructed in Mugalsarai-New Bhaupur Section. In addition one Guest House and one Club/Institute have also been planned.

1.1.7 A centralized Operational Control Centre (OCC) for the entire Eastern Dedicated Freight Corridor(Ludhiana-Khurja-Dadri-Bhaupur-Mughalsarai-Dankuni), i.e. including EDFC Phase-II, shall be located at Allahabad. The OCC shall house the Train Management System and Traction Power SCADA for entire EDFC. All the controllers viz. Chief Controllers, Deputy Chief Controller, Assistant Controller, Traffic Controllers, Track Controller, Traction Power Controller and Signalling Fault Management Controller shall monitor and manage all train operations and associated activities, including maintenance of entire EDFC from the OCC.

1.1.8 Communication and Control Signals for both Signalling & Telecommunications shall be distributed around the EDFC Phase-II via an Optical Fibre Data Transmission Network.

1.2 Purpose

1.2.1 This Specification covers the Design, Manufacturing, Delivery, Installation, Testing & Commissioning and Defects Notification Period Support for the Telecommunication System to be supplied under this Contract.

1.2.2 The Main Purpose of the Telecommunication System shall be to provide Voice and Data Transmission Capabilities throughout the EDFC Phase-II to enable efficient operation and management of the Railway System. In addition, the Telecommunication System shall be required to distribute an accurate Time Signal throughout the EDFC Phase-II.

1.2.3 Telecommunication System shall also meet all the Data Communication requirements of Signalling and Electrification Works.

1.3 Scope Of Work

1.3.1 General Requirements

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

1.3.1.2 The Telecommunication System shall include, but not be limited to, the Sub-systems namely, Optical Fibre Communication System, Data Networking System, Telephone System, GSM-R based Mobile Train Radio System, Master Clock System, VHF Communication System and associated 48 V DC Power Supply System.

1.3.1.3 The scope shall include erection of towers in detour portion of the track near BTS as defined in this Particular Specifications.

1.3.1.4 The scope shall also include any upgradation/augmentation/reconfiguration, as required, of equipment provided under Contract Package CP-104 to meet the requirements as defined in this Particular Specifications.

1.3.2 Scope of Supplies

1.3.2.1 The scope of supply shall include all necessary Hardware, Software, Firmware, Accessories, Materials and Documentation for Telecommunication System. The detailed requirements shall be as given in this Particular Specification.

1.3.2.2 The scope of supply shall also include supply of Spares and Tools & Test Equipment as stipulated in this Particular Specification.

1.3.3 Scope of Services

1.3.3.1 The scope of services to be performed by the Contractor shall include Design, Manufacturing, Delivery, System Assurance, Storage, Installation, Testing and Commissioning of the Telecommunication System. The detailed requirements shall be as given in this Particular Specification and General Specification.

1.3.3.2 The scope of services shall also include, but not limited to, Project Management, Interface Management, Quality Management, System Assurance Management, Safety Management, EMC Management, Design, Procurement & Manufacturing Management, Construction & Installation Management, Overall Site Supervision & Management, SHE Management, Completion Management, Defect Liability Management, etc.

1.3.3.3 The scope of services shall also include Maintenance Support Services including rectification & removal of defects during the Defect Notification Period and Training for Employer's Personnel.

1.4 Relevant Documents

1.4.1 This Particular Specification (PS) shall be read in conjunction with the Conditions of Contract, the General Specification (GS), and any other document forming part of the Contract.

1.4.2 In the event of a conflict between the GS and the PS (Telecommunication Works), the requirements of the PS (Telecommunication Works) shall prevail.

1.4.3 In the event of a conflict between this document and others, the following precedence shall apply:

(1) This Document-Particular Specification (Telecommunication Works).
(2) General Specification.
(3) Indian Standards referenced in this document.
(4) International Standards referenced in this document.
(5) Other International Standards.
(6) Other National Standards.

1.4.4 Notwithstanding the contents of sections above, the Contractor shall always immediately seek advice from the Engineer in the event of conflicts between specifications and decision of the Engineer shall be final and binding.

1.5 Infringement of Patent Rights

1.5.1 The Employer will not be responsible for infringement of Patent Rights arising due to similarity in design, manufacturing process, use of similar components in the design and development and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such dispute/matters shall lie with the Contractor.

G **End of Chapter 1** G

CHAPTER 2 – ABBREVIATIONS & STANDARDS

2.1 Abbreviations

ACL	Access Control List
ALARP	As Low As Reasonably Practicable
ALH	Auto Location Hut
BGP	Border Gateway Protocol
BOQ	Bill of Quantity
BSC	Base Station Controller
BSS	Base Station Sub system
BTS	Base Transceiver Station
DC	Direct Current
DFC	Dedicated Freight Corridor
DFCC	Dedicated Freight Corridor Corporation
DHCP	Dynamic Host Configuration Protocol
DID	Direct Inward Dial
DNP	Defect Notification Period
DOD	Direct Outward Dial
DOT	Department of Telecom, Government of India
DLT	Direct Line Telephone
DTMF	Dual Tone Multiple Frequencies (Signalling)
DTN	Data Transmission Network
DWC	Double Wall Corrugated
EDFC	Eastern Dedicated Freight Corridor
EIRENE	European Integrated Railway Radio Enhanced Network
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
E&M	Electrical & Mechanical
EN	European Norm
EoS	Ethernet over SDH

EPL	Ethernet Private Line
EVPL	Ethernet Virtual Private Line
E-LAN	Ethernet Local Area Network
EoMPLS	Ethernet over MPLS
ETCS	European Train Control System
ETSI	European Telecommunication Standards Institute
FRS	Functional Requirement Specifications
GCR	Group Call Register
GOS	Grade Of Service
GPS	Global Positioning System
GUI	Graphical User Interface
GSM	Global System for Mobile communication
GSM-R	Global System for Mobile communication – Railway
HCS	Hundred Call Seconds
HDPE	High Density Polyethylene
HLR	Home Location Register
HSRP	Hot Standby Router Protocol
ID	Identification
IMD	Integrated Maintenance Depot
IMSD	Integrated Maintenance Sub-Depot
IS-IS	Intermediate System to Intermediate System
IGMP	Internet Group Management Protocol
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IOT	Inter-Operability Test
IP	Internet Protocol
IR	Indian Railways
IRS	Indian Railways Standards
ISDN	Integrated Services Digital Network

ITU	International Telecommunication Union
ITU-T	International Telecommunications Union – Telecommunication Standardization Sector
KMPH	Kilo Metre Per Hour
LAN	Local Area Network
LC	Level Crossing
LCD	Liquid Cristal Display
LDP	Label Distribution Protocol
L2PT	Layer 2 Protocol Tunnelling
LED	Light-Emitting Diode
MDF	Main Distribution Frame
MMI	Man Machine Interface
MPLS	Multi-Protocol Label Switching
MSC	Mobile Switching Centre
MTBF	Mean Time Between Failure
MTRC	Mobile Train Radio Communication
MTTR	Mean Time To Repair
NMS	Network Management System
NTP	Network Time Protocol
OCC	Operation Control Centre
ODF	Optical Distribution Frame
OFC	Optical Fibre Cable
OEM	Original Equipment Manufacturer
OSPF	Open Shortest Path First
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PDH	Plesio-chronous Digital Hierarchy
PIJF	Paper Insulated Jelly Filled
POP	Point of Presence
PSTN	Public Switched Telephone Network

PTT	Press To Talk
QoS	Quality of Service
RA	Remote Access
RAMS	Reliability, Availability, Maintainability and Safety
RCIL	Railtel Corporation of India Limited
RDSO	Research Design and Standards Organization
RH	Relative Humidity
RDC	Radio Dispatcher Console
REC	Railway Emergency Call
RF	Radio Frequency
RSI	Repetitive Strain Injury
SC	Station Controller
SCADA	Supervisory Control and Data Acquisition
SCR	Station Controller Room
SDH	Synchronous Digital Hierarchy
SHE	Safety, Health and Environment
SINAD	Signal to Noise And Distortion Ratio
SM	Single Mode
SMSC	Short Message Service Centre
SNCP	Sub-Network Connection Protection
SOD	Schedule of Dimension
SP	Sectioning Post
SRS	System Requirement Specifications
SSP	Sub-Sectioning Post
S&T	Signalling & Telecommunication
TDM	Time Division Multiplexing
TER	Telecommunication Equipment Room
STM	Synchronous Transport Module
TCP/IP	Transmission Control Protocol / Internet Protocol

TMN	Telecommunications Management Network
TPC	Traction Power Controller
T-LDP	Targeted Label Distribution Protocol
TSS	Traction Sub-Station
TRAU	Trans-coder Rate Adaption Unit
TRX	Transceiver
UPS	Uninterruptible Power Supply
UPSR	Uni-directional Path Switched Ring
UTC	Universal Time Co-ordinate
VC	Virtual Container
VDU	Video Display Unit
VMS	Voice Mail System
VPN	Virtual Private Network
VRS	Voice Recording System
VF	Voice Frequency
VHF	Very High Frequency
VoIP	Voice over IP
VLAN	Virtual Local Area Network
VLR	Visitor Location Register
VPWS	Virtual Private Wire Services
VRLA	Valve Regulated Lead Acid
WAN	Wide Area Network
WPC	Wireless Planning Committee

2.2 List of standards/Specifications

STANDARDS/SPECIFICATIONS	TOPIC
IEC 62278	RAMS
EN 50121, IEC 61000	EMC - Intra & Inter System
EN 50121, IEC 61000	EMI – Equipment is adequately protected against EMI, EMC – EMC testing
ITU-T Rec. 803	Proven SDH technology
EN-50159	All vital & safety related information shall be implemented as per this standard in both First & Second OFC network
G.7041	SDH equipment shall be equipped with EoS at 10/100 Base T
IEEE 802.1d	Re: In-built Layer-2 Bridging & Aggregation functionality
IEEE 802	Layer-3, Layer-2 switches shall support: IEEE 802.3ad – Link aggregation control IEEE 802.1Q – VLAN on all ports IEEE 802.1q – VLAN (tagging) IEEE 802.1x – Port based authentication IEEE 802.1d – Spanning Tree Protocol IEEE 802.1s – Multiple Spanning Tree Protocol IEEE 802.1w – Rapid Spanning Tree Protocol
IEEE 802	Layer 2 Switch IEEE 802.3 – Support Half Duplex IEEE 802.3u – Full Duplex IEEE 802.3ab – Auto Negotiation
RFC 2138	For DHCP, RADIUS Protocol
IEEE 802.1p	Classification & Scheduling on all ports
IEEE 802.1x	Access control mechanism via Authentication, Authorization & Cryptographic key Validation
RDSO/SPN/TC/66/2007	Control Communication System shall have equipment as per RDSO specs
RDSO Spec: IRS: TC 30-05	Underground Jelly Filled Telecom Quad cable
IEC 60065 IEC 60364	All equipment must comply to System Safety Requirement
ITU-T Rec. G.822	Allowable clock slip in PBX network internal clock when Master Clock is absent
RDSO Spec: IRS: TC 41-97	Spec of Polythene Insulated Jelly Filled Cable

EIRENE FRS 7.3 EIRENE SRS15.3	MTRC
RDSO Letter: STT/WL/MTRC/503 Dated 11.11.2005	Numbering Plan
IEC 60950	Safety of Information Technology Equipment
IEC 60364	Electrical Installations of Buildings
EIA/TIA–222-E IS 800,808, 226/2062/ 1367,1161, 2629,5358	Antenna Tower at Radio Base Station
IS 4759	Hot dipped galvanized iron compliance for towers
IEEE 802.3af	PoE
RDSO/SPN/TL/23/99 Ver 4.0	Spec for battery chargers
RDSO Spec: IR S93-96 TEC Spec: GR/BAT-01/03 March 2004	VRLA battery cells
ITU-T Rec. G.652	ODF: Optical connectors compliance
IEEE 1100 NFPA 780 IEC 1024	Earthing System Standards
ITU-T M-3010	ITU-T Recommendation on Principles for Telecommunication Management Network.
ITU-T Rec. G.823	ITU-T Recommendation on Control of Jitter and Wander in 2 Mbps Digital Network
ITU-T Rec. G.825	ITU-T Recommendation on Control of Jitter and Wander in SDH Digital Network
ITU-T Rec. G.712	ITU-T Recommendation on Transmission performance characteristics of pulse code modulation channels
ITU-T Rec. G.821	ITU-T Recommendation on Error performance of an international Digital Connection
RDSO Spec: IRS: TC 55-2006	RDSO specification for 24 F Armoured Optical Fibre Cable
IEC60793 & IEC60874	IEC Specification for Optical Fibres and Connectors

G End of Chapter 2 G

CHAPTER 3 - PERFORMANCE REQUIREMENTS

3.1 General

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

3.1.2 The System excluding battery cells shall be so designed as to have a minimum of 15 years of Service Life operating continuously. The life of Valve Regulated Lead Acid Battery Cells shall not be less than 7 years. Further, the life of all the cables including Optical Fibre Cables, Jelly Filled Telecom Quad Cable, Telephone Cables and RF Cables shall not be lower than 25 years and life of Radio Towers/Mast shall not be less than 40 years.

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

3.1.4 The System shall, to the extent practicable, have no credible failure mode, which will directly cause an interruption or delay in the freight services. The Contractor shall demonstrate that the probability of occurrence of the credible failure mode, if any, has been reduced to ALARP (as low as reasonably practicable) and no further cost-effective means of improving reliability can be identified.

3.1.5 Reliability-Availability-Maintainability-Safety (RAMS) Plan for Telecommunication System shall be developed and implemented in accordance with IEC 62278.

3.1.6 Wherever the equipment being provided under Contract Package CP-104 for EDFC Phase-1 is being upgraded/augmented/reconfigured, the service life of these upgraded/augmented/reconfigured equipment shall be minimum 15 years from date of commissioning of this upgradation/augmentation/reconfiguration.

3.2 Reliability Requirements

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

3.2.2 The Contractor shall submit Mean-Time-Between-Failures (MTBF) figure for major equipment of each sub-system as specified in relevant chapters of this Particular Specification. It should be possible to achieve the required level of system availability, as specified in the relevant chapters of this Particular Specification, with these MTBF figures.

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

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

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

3.3 Availability Requirements

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

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

configuration of each sub-system.

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

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

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

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

3.4 Maintainability Requirements

3.4.1 The Contractor's Response Time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at site where the faulty equipment is located.

3.4.2 The System shall be designed such that the Mean Time to Repair (MTTR) shall not exceed 2 hours. The MTTR shall include the diagnostic time, active repair/replacement time and adjustment/testing time on site, but shall exclude the Contractor's Response Time.

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

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

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

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

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

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

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

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

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

3.5 System Safety Requirements

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

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

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

3.5.4 The design of the System shall minimise the build-up of static, as well as the effects of

static discharge during maintenance.

3.5.5 Components or materials containing toxic chemicals or asbestos shall not be used in the System unless absolutely necessary and unavoidable. Specific Approval of Engineer shall be obtained before using these components or materials containing toxic chemicals or asbestos.

3.6 Electromagnetic Compatibility (EMC)

3.6.1 The Contractor shall prepare and submit, EMC Management Plan, for review by the Engineer, which shall be based upon a top-down approach, define the EMC philosophy, activities, means of control for the design processes and EMC submissions to be supplied to demonstrate compliance with the PS and GS. The EMC Management Plan shall also identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the Engineer for review.

3.6.2 In respect of the EMC Design Documentation, the Contractor shall demonstrate by theoretical analysis that the design, of the electrical and electronic systems under this PS, is fully compliant with the EMC requirements identified.

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

3.6.4 The Contractor shall ensure that all Intra-system EMC are taken care of through proper design and other measures in accordance with EN 50121 and IEC 61000.

3.6.5 The Contractor shall liaise and co-ordinate with all other Contractors in the exchange of EMC data and related equipment performance characteristics. Inter-system EMC between Telecommunication System and other electrical and electronic equipment shall be in accordance with EN 50121 and IEC 61000.

3.6.6 The Contractor shall ensure that all electrical and electronic apparatus of Telecommunication System is designed and protected against electromagnetic interference in accordance with EN 50121 and IEC 61000, to operate without degradation of quality, performance or loss of function in the electromagnetic environment of the Project. Adequate safety margins between the immunity levels of the Telecommunication System and the emission levels of other electrical and electronic equipment must be maintained.

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

3.6.8 EMC considerations shall be incorporated in the Contractor's procedures for product safety and design Verification.

3.6.9 EMC Testing shall be carried out on all equipment identified in the design stage which requires attention regarding EMC in accordance with IEC 61000 and to meet overall compliance to EN 50121.

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

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

3.6.12 The Contractor must be fully aware of the EMC requirements and any modifications to systems and equipment carried out by the Contractor during the Defects Notification Period shall not cause the immunity, or emission levels of the installed system and equipment to exceed such values.

3.6.13 Any equipment consisting of sensitive electronic components that is likely to be handled or touched by any person shall be protected against electrostatic discharge and shall be tested as defined in IEC 61000-4-2.

G End of Chapter 3 G

CHAPTER 4 - DESIGN REQUIREMENTS

4.1 Design Approach

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

4.1.2 The technologies adopted for the design of Telecommunication System shall be:

(1) field proven with past successful applications references

(2) conforming to open international standards

4.1.3 The System design shall be based on redundant hardware in hot-standby configuration to minimise the single point of failure of the System.

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

4.1.5 The Contractor shall submit a Design Plan. The design shall be in three stages of Preliminary Design, Detailed Design and Installation Design. The Design Plan shall define Contractor's policy for the design of works and shall without limitation, define;

(1) The organization of Contractor's design staff with particular reference to the design interfaces in detail;

(2) The specific allocation of responsibility and authority given to identified staff with particular reference to the review and verification of design specification, drawings and calculations by the Contractor in detail;

(3) The design and performance requirements which shall be defined in terms of basic data and design assumptions made, relevant codes, standards and regulatory requirements, safety, reliability, security and environmental requirements and commissioning requirements in detail;

(4) The process of formal design review, authorization and approval of design documentation; and

(5) The process of independent design Verification and Validation.

4.1.6 During the Preliminary Design, the Contractor shall prepare System Requirement Specifications (SRSs) for each Sub-system and submit to the Engineer for review, which includes, as a minimum, operational, functional, performance and design requirements. System Requirement Specification shall serve as Contractor's top level design document and shall state all the requirements completely and unambiguously and how each requirement can be verified and validated.

4.1.7 Preliminary Design of individual Sub-systems shall be prepared and submitted to the Engineer for review, which includes, as a minimum, the function of each System, Sub-system, equipment or other element within the overall SRS and specify the relationship and interfaces between each element of the System, including the systems of the interfacing elements of the other Contractors.

4.1.8 The Detailed Design for individual Sub-systems shall be developed based on the Preliminary Design for individual Sub-systems and submitted to the Engineer for review. Detailed Design shall also include electrical and control schematics to illustrate, how the various operational and functional requirements can be achieved.

4.1.9 Software design & development shall also be carried out during Detailed Design stage, and shall be included in the Detailed Design Submission for review of Engineer.

4.1.10 The Detailed Design shall include as necessary all technical aspects of all interfaces with

other elements of the Contractor's overall design and of any interfaces with works being supplied by other Contractors. Detailed interconnection specification shall also be developed during this stage and included in the Detailed Design.

4.1.11 The Detailed Design shall also include detailed design calculations, and supporting drawings, documents, etc., for the applicable subsystems The design calculations shall demonstrate that the Contractor's Design fully complies with the requirements given in the specifications and shall further demonstrate that the ratings, capacity and quantity of the proposed equipment are adequate.

4.1.12 The Contractor shall also furnish the following calculations and analysis for each Sub-system as a minimum:

(1) Estimation of the power consumption and heat dissipation per equipment location.

(2) Prediction of the reliability and availability of the Sub-systems.

4.1.13 Upon approval of Detailed Design, the Contractor shall produce the respective Installation Design, which shall include, inter alia, the Equipment Layout Drawings, System Specifications, Installation Drawings, Cable Route Plan, Circuit Diagrams, Termination Plans, Configuration Details and all other associated documents necessary to supplement the design covered in the Detailed Design and to comply with the Contract regarding the installation of the equipment such as detailed Method Statement, Safety Risk Assessment etc.

4.1.14 As part of Installation Design, specified clearance as per SOD of track side equipment in millimetres from centre line of adjacent track(s) shall be prepared in a tabular form.

4.1.15 Only those drawings and documents of Installation Design that have been endorsed and certified as having been reviewed shall be issued to the Site.

4.1.16 If the Contractor identifies the need for any change to the design due to site conditions or other reason, then the Contractor shall produce a Design Change Notice or Field Change Notice.

4.1.17 The Design Verification and Validation Plan, supplementary to Design Plan shall be prepared by the Contractor in order that design Verification and Validation activities are properly directed.

4.1.18 The Contractor shall by means of the design Verification and Validation process demonstrate that all requirements within the specifications have been met. For this the Contractor shall prepare a Design Verification Table (DVT) that identifies the Contractor's proposed methodology for demonstrating compliance, and submit to the Engineer for review. DVT shall include Acceptance Criteria for achieving the requirement. DVT shall be monitored throughout the design and construction of the works. Changes, if any to the DVT, shall be submitted to the Engineer for review before implementation.

4.2 Design Review

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

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

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

(1) The following issues shall be addressed during Design Review Meetings:

- Design Progress
- Interface Issues

(2) In terms of relevant clauses of General Conditions of Contract & Particular Conditions of Contract, the Engineer shall obtain approval of Employer for

Preliminary Design and Detailed Design Submissions.

4.3 Man Machine Interface Design

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

4.3.2 All MMIs shall be equipped with virus checking and anti-virus protection facilities to prevent from virus infection.

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

4.4 Submission of Samples

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

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

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

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

4.5 Equipment Design

4.5.1 **General Considerations**

(1) Specific equipment design requirements for individual Subsystems are given in relevant chapters of this Particular Specification.

(2) The offered equipment shall be field proven with past history of successful performance in railway environment.

(3) All equipment shall be designed and constructed to operate without degradation in quality, performance or loss of function in the electromagnetic environment prevalent in a standard Heavy Freight Corridor Railway System.

(4) All Housing, Enclosures and Cabinets housing outdoor equipment shall be compliant to IP65 for Ingress Protection.

4.5.2 **Fire and Smoke Precautions.**

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

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

(3) All necessary measures shall be adopted to prevent the creation of hazardous conditions arising out of overheating and/or ignition of cables.

(4) All of the above requirements shall be fully complied with without compromising any of the mechanical or electrical properties of the cables.

(5) Portable Fire Extinguishers shall be provided in Telecommunication Equipment Room/Telecommunication Power Supply equipment Rooms at Stations, Auto Location Hut, LC gates, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Residential Colonies etc. Portable fire Extinguishers

shall be compliant to NFPA 10 standard and suitable for electrical equipment.

4.6 Environmental Conditions

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

4.6.2 Unless otherwise specified, all indoor Telecommunication Equipment installations shall be designed for operation continuously in environmental temperatures range of -5°C to +55°C.

4.6.3 Telecommunication Equipment Room (TER) at OCC and Stations shall be provided with Air-Conditioning. Provision of Air-Conditioning in TERs at OCC is covered under Contract Package CP-104, while provision of Air-Conditioning in TERs at Stations is covered under Contract Package CP-204. TER at OCC is classified as 'Class-A' and TERs at Stations are classified as 'Class-B1' under Clause 2.5.5 of General Specifications.

4.6.4 Telecommunication Equipment Room (TER) at Auto Location Huts, LC gates, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Residential Colonies etc. shall be provided with air-conditioning. Air-Conditioning in TERs at above locations shall be provided by the Contractor under this Contract. TERs at above locations are classified as 'Class-B1' under Clause 2.5.5 of General Specifications.

4.6.5 Telecom Power Supply Equipment Rooms at Stations, Auto Location Huts, LC gates, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Residential Colonies etc. shall be provided with suitable means to regulate temperature and maintain air-circulation with 1+1 standby, within limits so as to facilitate proper working of Power Supply Equipment and VRLA battery as during summer time the temperature inside the equipment room is likely to reach very high. These provisions of to regulate temperature and maintain air-circulation shall be provided by Contractor under this Contract. Telecom Power Supply Equipment Rooms at these locations are classified as 'Class-B2' under Clause 2.5.5 of General Specifications.

G**End of Chapter 4** G

CHAPTER 5 - OPTICAL FIBRE COMMUNICATION (OFC) SYSTEM REQUIREMENTS

5.1 General

5.1.1 The OFC System shall be a highly reliable system since it shall be the primary means of communications between OCC, Stations, Auto Location Huts, LC Gates, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Quarters etc. on which a number of other operationally critical systems will rely.

5.1.2 The OFC System shall provide a high degree of availability and redundancy by operating on two independent optical fibre rings. Proven technology of SDH (Synchronous Digital Hierarchy) as per ITU-T Rec. G.803 shall be used.

5.1.3 The OFC System shall be capable to transport all of the user communication requirements. The OFC System shall provide sufficient bandwidth to cater for the communication requirements of various systems under this Contract as well as under Contract Package CP-204.

5.1.4 This OFC system shall be integrated with OFC System being provided under Contract Package CP-104 for New Bhaupur-New Khurja section.

5.2 Scope of Supply for OFC System

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

(1) SDH Equipment;
(2) Flexible Access Multiplex Equipment;
(3) Network Management System for OFC System;
(4) All required software and licenses;
(5) Single Mode Optical Fibre Cables;
(6) Splice Boxes
(7) Distribution Frames;
(8) Equipment Cabinets, Racks and Cubicles;
(9) Terminating and Interconnecting Equipment;
(10) All required connectors;
(11) Installation materials;
(12) All required accessories;
(13) All required power and data cables; and
(14) Earthing Arrangement and Termination Protection Devices.

5.3 System Requirements

5.3.1 The OFC System shall be a Synchronous Digital Hierarchy (SDH) Optic Fibre Communication Network, based on open standards and fully conforming to the relevant ITU-T Recommendations.

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

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

5.3.3 Optical Fibre Cable Network

5.3.3.1 There shall be two separate optical fibre cable backbone networks namely First Network and Second Network. Each of these two networks shall be formed by two outdoor single

mode optical fibre cables. The normal and protected routes of these networks shall be routed through different fibre cables with route diversity.

5.3.3.2 The First Network shall be formed by two optical fibre cables, preferably one laid along the up-track and the other laid along the down-track ensuring route diversity, from Mughalsarai to New Bhaupur and terminated on Optical Distribution Frames(ODFs) in TERs at Stations and New Bhaupur Station only. Further, this First Network shall be taken to OCC by laying two additional optical fibre cables with route diversity from New Manauri Station to Subedarganj Station of IR and splicing through with two optical fibre cables, being laid from Subedarganj (IR) to OCC and terminated on ODFs in TERs at OCC under Contract Package CP–104.

5.3.3.3 The Second Network shall be formed by two optical fibre cables, preferably one laid along the up-track and the other laid along the down-track ensuring route diversity, from Mughalsarai to New Bhaupur and terminated on ODFs in TERs at Stations, New Bhaupur Station, Auto Location Huts, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Quarters and any other location as required. Locations of termination of optical fibre cables of Second Network can be clubbed based upon design of other Systems/Sub-systems under this Contract as well as under Contract Package CP–204, while meeting overall Telecommunication Requirements.

5.3.3.4 In addition to SDH Network, optical fibres shall also be used for Data Networking System (as stipulated in Chapter-6) and Signalling Systems (as required).

5.3.3.5 All the optical fibre cables shall have a minimum fibre count of 24 fibres. At least 25% of fibres within each cable shall be reserved as spares for future use.

5.3.3.6 The optical fibre cables within Station/IMD/IMSD and along the track shall be laid along different routes to provide 100% route diversity.

5.3.3.7 At least 10 metres slack in each optical fibre cable shall be provided for future network modification before taking cables to ODFs.

5.3.3.8 All fibres of optical fibre cables, including the spare fibres, at ODF shall be either spliced through or spliced with optical pigtails or terminated at the optical patch panels. At least 10 meter optical fibre cable loop shall be provided for each cable inside a suitable underground chamber at all Optical Fibre Cables Jointing Locations.

5.3.4 SDH Network

5.3.4.1 The SDH Nodes shall consist of STM Multiplexers with Optical Line Terminals connected to optical fibre cable backbone networks to form the SDH Network of the OFC System.

5.3.4.2 The First Network shall carry all Voice & Data Communication between OCC and Stations. The First Network shall also carry all Train Management System information and other Vital & Safety Related Information between OCC and Stations. All Vital & Safety Related System using OFC System shall be implemented as per EN-50159.

5.3.4.3 The Second Network shall carry all Voice (including Emergency Communication) and Data (including Traction Power SCADA) Communication between Stations and Auto Location Huts, LC Gates, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Staff Quarters etc.

The Second Network shall also carry all Signal Control Information, Track Vacancy Detection Information and other Vital & Safety Related Information between Stations, New Bhaupur Station, Auto Location Huts, LC Gates and Interfacing IR Stations,. All Vital & Safety Related System using OFC System shall be implemented as per EN-50159.

5.3.4.4 Each SDH Node of the First Network shall be at least STM-16 level or higher in the SDH hierarchy. The exact level of SDH Node in SDH hierarchy shall be determined by the Contractor to meet the bandwidth requirements for sub-systems under this Contract as well as under Contract Package CP-204 with 50% Spare Capacity. SDH Node of First Network shall be equipped with minimum 2XSTM-16o and 4XSTM-4o Interfaces.

5.3.4.5 Each SDH node of the Second Network shall be at least STM-4 level or higher in the SDH hierarchy. The exact level of SDH Node in SDH hierarchy shall be determined by the Contractor to meet the bandwidth requirements for subsystems under this Contract as well as under Contract Package CP-204 with 50% Spare Capacity. SDH Node of Second Network shall be equipped with minimum 4XSTM-4o Interfaces.

5.3.4.6 SDH Nodes at Stations as well as at New Bhaupur Station shall be common for First Network & Second Network and equipped with Digital Cross Connect at VC4 and VC12 levels.

5.3.4.7 SDH Node at New Bhaupur Station shall be integrated with SDH Node being provided at New Bhaupur Station under Contract Package CP-104 using STM-16o interface with 1+1 Protection. Similarly SDH Node at OCC shall be integrated with SDH Node at OCC being provided under Contract Package CP-104 using STM-16o interface with 1+1 Protection.

With above integration, it shall be possible to make provisioning of VC4s and VC12s across SDH Nodes provided under this Contract as well as under Contract Package CP-104 to meet the requirement of various systems/subsystems under this Contract as well as under Contract Package CP-204.

5.3.4.8 SDH Traffic of New Bhaupur-New Khurja section shall be carried over to OCC using dedicated VC4s over First Network being provided under this Contract. This traffic shall be terminated at SDH Node at OCC being provided under Contract Package CP-104.

5.3.4.9 Control/Processor Card (if its failure results in affecting traffic), Switch/Matrix Unit & Power Supply Modules of SDH Equipment shall be provided with 1+1 Protection.

5.3.4.10 SDH Nodes at Mughalsarai and New Bhimsen shall be equipped with additional 2xSTM-16o interfaces for their future integration with SDH Network of Mughalsarai-Sonnagar and Khurja-Dadri section respectively.

5.3.5 Access Network

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

- STM optical and electrical signals of same/lower levels;
- 2Mbps or the E1 tributaries;
- Ethernet tributaries at 10/100 BaseT;

5.3.5.2 The SDH Nodes shall be fully equipped minimum for 63(sixty three) 2 Mbps tributaries. All the tributaries shall be terminated on distribution frame for access.

5.3.5.3 Protection switching mechanisms shall be provided for the tributaries of the SDH Node. 2 Mbps tributaries shall be provided with 1:3 (Minimum) Protection and all the other tributaries shall be provided with 1+1 Protection.

5.3.5.4 The SDH Nodes of First Network shall be equipped with minimum 8 Ethernet 10/100 BaseT tributaries. SDH Nodes of Second Network (excluding at Stations) shall be equipped with minimum 4 Ethernet 10/100 Base T tributaries.

5.3.5.5 Flexible Access Multiplexers or Primary Order Multiplexer shall be provided with each and every SDH Nodes to connect to the 2Mbps tributaries of the SDH Nodes for direct access of channel circuits with data rate lower than 2Mbps.

5.3.5.6 Flexible Access Multiplexer or Primary Order Multiplexer shall have minimum 50% spares for all types of Channel Circuits (Minimum 1 for all types of Channel Circuits).

5.3.5.7 All the channel circuits, including spare circuits, shall be terminated at the main distribution frame, digital distribution frame as appropriate for circuit access.

5.3.5.8 The OFC System shall provide Voice and Data Communication Network/Channels or Bandwidth to meet the requirement for system/subsystems being provided under this Contract as well as under Contract Package CP-204.

5.3.5.9 Ethernet Connections for each application need to be implemented through Ethernet Virtual Private Line Service.

5.3.5.10 The OFC System shall include a bandwidth management tool to ensure sufficient transmission capacity for each application to function under all traffic circumstances on the OFC System.

5.3.6 OFC System Network Synchronisation

5.3.6.1 The OFC System Synchronisation shall adopt master and slave synchronisation method.

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

5.3.6.3 The SDH Equipment shall derive the synchronisation timing signal from, but not limited to the following in order of priority;

- Master Clock Equipment/Sub Master Clock Equipment;
- an internal clock of the SDH Equipment;
- incoming STM Signal;
- incoming 2 Mbps Signal

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

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

5.3.6.6 The SDH equipment shall provide user-selection of synchronizing the outgoing STM signal in one of but not be limited to the following synchronization modes:

(1) Internal Clock Mode; and
(2) Incoming STM to outgoing STM Signals.

5.3.6.7 When all incoming timing reference is lost, the equipment shall be capable of entering into Holdover Mode.

5.3.6.8 Synchronization network shall be protected against single transmission network node/link failure, that is, a single node/link failure shall not cause a complete loss of synchronization reference to any other transmission network node.

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

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

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

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

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

5.3.7 Network Protection

5.3.7.1 The SDH Equipment shall support Protection Mechanism such as Linear Multiplex Section Protection, Sub Network Connection Protection (SNCP), Multiplex Section Shared Protection Ring (MSSP Ring).

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

5.3.7.3 The normal and protected routes shall be routed through different Optical Fibre Cables with path diversity.

5.3.7.4 Automatic path protection switching shall occur upon detection of failure or alarm conditions which will affect the quality of signal transmission. The protection switching shall be completed within 50ms.

5.3.7.5 Manual Protection Switching facility shall be available. Manual Protection Switching shall be initiated by a switch command from the NMS. The protection switching shall be completed within 50ms.

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

5.3.7.7 The Flexible Access Multiplex Equipment shall be provided with 1+1 Redundancy for E1 Channels. Further 1+1 Protection for Control (if its failure results in affecting traffic) & Power Supply Modules/Cards shall be provided in Flexible Access Multiplex Equipment.

5.3.7.8 No single failure shall affect the availability of OFC System or the Interfaces.

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

5.3.8 Service Telephone / Order Wire

5.3.8.1 A Service Telephone/Engineers Order Wire with handset shall be provided at each and every SDH Node locations for point-to-point and point-to-multipoint voice communication calls between maintenance staff at different SDH Node locations. It shall permit selective and group call functions.

5.3.8.2 The operation of Service Telephone/Engineers Order Wire shall not affect the operation of the signal transmission within the OFC System.

5.3.9 Network Management System

5.3.9.1 At the OCC, Network Management System (NMS) shall be provided to carry out Real-time centralised and remote monitoring and measurement of network status and performance, and the ability to take prompt action to control the flow of traffic when necessary. The equipment to be managed shall include SDH Equipment, Flexible Access Multiplexer/Primary Order Multiplexers, etc.

5.3.9.2 NMS Workstation(s) shall be installed at the OCC in TER (or any other location as decided by the Engineer) for the operation of the NMS.

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

5.3.9.4 NMS Workstation(s) shall be equipped with a log printer for alarm and event print-out.

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

5.3.9.6 The mass storage device shall provide facilities for downloading the configuration and alarm data files to CD/DVD/Pen Drive.

5.3.9.7 Laptop Portable Service Terminals (4 numbers) loaded with Network Management Software shall also be provided for maintenance access to the network elements at various node locations.

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

5.3.9.9 The NMS shall provide Operations, Administration, Maintenance & Provisioning (OAM&P) functions in accordance with the Telecommunications Management Network (TMN) concept described in ITU-T Recommendations M-3010.

5.3.9.10 **Alarm and Status Monitoring**

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

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

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

(a) loss of frame alignment;
(b) high error rate alarm;
(c) loss of pointer;
(d) loss of synchronisation;
(e) out of frame alignment;
(f) alarm indication;
(g) high/low optical power;
(h) high laser bias;
(i) tributary unit failure;
(j) power unit failure;
(k) external synchronisation failure; and
(l) any card/module failure.

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

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

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

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

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

5.3.9.11 **Performance Monitoring**

(1) The NMS shall calculate, display and provide print-out of the performance statistics for the SDH System.

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

(a) optical power transmitted;
(b) optical power received;
(c) degraded duration in minutes;
(d) severely error seconds;
(e) protection switching counts;
(f) protection switching duration;

(g) error seconds of the received E1 and above signals; signal level of the received E1 and above signals;
(h) error free seconds of the received E1 and above signals; and
(i) bit error rate of the received E1 and above signals.

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

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

5.3.9.12 **Network Configuration and Provisioning**

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

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

(a) interface port allocation;
(b) low speed (64 kbps & lower) interface cards configuration;
(c) lower order multiplex time slot allocation and routing;
(d) higher order multiplex/cross-connect switch configuration;
(e) logging of circuit routing data logged into configuration database;
(f) operator's configuration checks function prior to main and backup database update; and
(g) the OFC links from junction stations to the adjacent station of IR

5.3.9.13 **User Interfaces**

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

5.3.9.14 The Contractor shall be responsible for carrying NMS Traffic of OFC Network of New Bhaupur-New Khurja section being provided under Contract Package 104, from New Bhaupur Station to OCC for Termination at NMS being provided under Contract Package 104. The design for above implementation shall be submitted to Engineer for approval before implementation.

5.4 Performance Specification

5.4.1 General

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

5.4.1.2 The OFC System shall be equipped with sufficient capacities and margins such that the System can operate properly under peak load or traffic conditions.

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

5.4.2 Reliability

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

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

(1) SDH Node Equipment
(2) Flexible Access Multiplexer or Primary Order Multiplexer
(3) Network Management System

5.4.3 Availability Requirements

5.4.3.1 The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the OFC System shall not be included in the determination of the system availability. The Contractor shall submit to the Engineer for review and consent the RAMS analysis for the OFC System to establish the requirements of availability specified here below.

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

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

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

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

5.4.3.5 The availability of any circuits below 2 Mbps level shall be better than 99.995%.

5.4.3.6 The Network Management System shall be considered unavailable if any functions provided by the Network Management System cannot be properly exercised. The availability of the Network Management System shall be better than 99.5%.

5.4.4 Maintainability Requirements

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

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

5.4.5 System Safety Requirements

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

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

5.4.5.3 All metallic enclosures shall be provided with an earth terminal.

5.5 Technical Requirements

5.5.1 General

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

(1) details on the specifications of each low speed data and voice channel interfaces below E1 level;
(2) details on all the available data and voice channel interfaces that the Flexible/Primary Order Access Multiplexer can be equipped with and, the limitations;
(3) details on the hardware modularity of each type of data and voice interface including the incremental number of interfaces that can be added to a partially equipped equipment shelf and limitations on the addition of the interfaces to the equipment already equipped with mixed types of interfaces shall be defined;
(4) details on the electrical and physical specifications of the local maintenance port which support remote and local operation, administration, maintenance and provisioning (OAM&P) functions of the equipment;

(5) the calculations of delay for signal transmission between SDH nodes;
(6) optical link budget calculations for all the transmission links;
(7) a list of alarms for which the faults shall be detected;
(8) format in which alarms shall be displayed and remotely accessed for printing and display;
(9) the details on the maximum number of tributary signal interfaces that can be supported by the SDH node and the limitations;
(10) the details of the synchronisation network design and a synchronisation plan which describes the fall back arrangement, failure and restore criteria used to determine the switchover of synchronisation sources, the associated timings under each failure and restoration event and the method used in preventing repeated switchovers of synchronisation sources automatically when intermittent/frequent failure occur in the clock sources;
(11) the details of the NMS design, flow of management traffic and protection against SDH node failures or cable failures;
(12) types and maximum number of transmission equipment supported by the NMS;
(13) self-healing mechanism, normal traffic flow diagrams, protected traffic flow details for various single and multiple cable(s) and/or node(s) failures; and
(14) normal and protected bandwidth allocation, maximum traffic capacity and method of calculation for the SDH Network.

5.5.1.2 The Contractor shall estimate and provide the bandwidth needed in order to guarantee the level of service required by all the Sub-systems.

5.5.1.3 At least 50% Spare Traffic Bandwidth and capacity between nodes shall be provided for SDH Network and Primary Multiplexer Network. Spare capacity shall be achieved by providing additional cards and/or modules.

5.5.2 Technical System Performance

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

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

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

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

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

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

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

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

(1) commands presented to the NMS from Management Workstation shall be processed and produce an appropriate output within 2 seconds maximum;
(2) real-time data presented to the Management Workstation from the network elements shall be processed and produce the appropriate output within 2 seconds maximum; and

(3) execution of parameter changes to SDH Nodes initiated through the NMS shall be less than 2 seconds.

5.5.3 Equipment Design Requirements

5.5.3.1 General

(1) The equipment design of OFC System shall be of standard rack with plug-in units. Hot swapping capability shall be provided for all cards/units including redundant power supplies. Hot-swapping of the plug-in units shall not affect the equipment operation.
(2) Equipment shall be equipped with protected test points for measurement and performance monitoring without affecting the traffic.
(3) Test access facilities shall be provided at different transmission levels.
(4) Equipment shall be provided with natural cooling arrangement, however if natural cooling arrangements are not adequate, the use of fan shall be provided.

5.5.3.2 SDH Equipment

(1) All SDH equipment shall conform and be compliant with ETSI 300 147 and relevant ITU-T Recommendations including of G.707 to G.709, G.781, G.783, G.784 and G.957.
(2) The SDH Nodes at OCC, Stations and new Bhaupur Station shall provide cross connect capabilities with a granularity of VC4, VC-3 and VC-12. These Nodes shall have Non-Blocking Cross connect with minimum capacity of 64X64 VC4 equivalents at VC4 level and 32X32 VC4 equivalents at VC3 and VC12 level.
(3) Each SDH Node shall be equipped with (1+1) redundant configuration at optical and electrical levels at STM-16(if applicable) and STM-4 level.
(4) The SDH Equipment shall operate satisfactorily at 48V+20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the maximum voltage.

5.5.3.3 Flexible Access Multiplex Equipment

(1) Flexible Access Multiplex Equipment shall conform to ITU-T Rec. G.703, G.704, G.706, G.707, G.708, G.709, G.711, G.732and G.823.
(2) Flexible Access Multiplex Equipment shall support Primary Multiplexing, Digital Branching and Digital Cross Connect.
(3) Flexible Access Multiplex Equipment shall support functionalities of Terminal Multiplexer, Protected Terminal Multiplexer, Drop/Insert Multiplexer, Bypass Multiplexer and Loop Protected Multiplexer.
(4) Flexible Access Multiplex Equipment shall support Omnibus Operation of Voice in Data Channels.
(5) Flexible Access Multiplex Equipment shall have in-built feature to provide details of performance data like AS, ES, SES, DM, etc. via NMS or via Laptop Service Terminal.
(6) Adequate numbers of Primary Multiplexers shall be provided so that there is no loss of Communication at any point of time.
(7) Flexible access multiplexer equipment shall be provided with 1+1 protection for all channel levels (VF, Data, etc.) with automatic switch over in case of fault.
(8) The optical line interfaces shall conform to ITU-T Rec. G.957.
(9) Flexible Access Multiplex Equipment shall operate satisfactorily at 48V+ 20% DC. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be capable of withstanding voltage spikes of up to 3 Volts over the maximum voltage.
(10) Channel Interfaces

(a) Where required, the Flexible Access Multiplex Equipment shall provide voice frequency interfaces for analogue telephone sets located not at the switch site, including but not be limited to the following, subject to the Review by the Engineer:

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

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

(c) The Contractor shall submit the details of all the channel interfaces which can be supported by the Flexible Access Multiplexer or The Primary Order Multiplexer.

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

(e) The Flexible Access Multiplex Equipment shall provide, as required, data interfaces, including but not be limited to the following, subject to the review by Engineer:

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

5.5.3.4 Network Management System

(1) The NMS shall provide Operations, Administration, Maintenance & Provisioning (OAM&P) functions in accordance with the Telecommunications Management Network (TMN) concept described in ITU-T Recommendations M-3010.

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

(3) The NMS shall be equipped with a proven real-time, multi-tasking operating system to support centralised network management of SDH and PDH equipment from OCC.

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

(5) The NMS shall support Q Interface conforming to ITU-T Rec.G.732, Q.811 & Q.812, Qecc. Interface as per ITU-T Rec.G.784 and F interface of V.24/V.28 type.

(6) Each Management Terminal shall be equipped with 24 inch colour LED backlit VDU to provide graphical representation and display of the network. A log printer shall be provided.

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

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

5.5.3.5 Cabling and Accessories

(1) Optical fibre cables shall be supplied as per RDSO specification no. IRS: TC 55-2006 with Latest Amendments from RDSO approved sources.

(2) The Optical Fibre Connectors shall comply with IEC60793 and IEC60874.
(3) The requirements on cabling accessories, digital distribution frames, optical distribution frames, main distribution frames are as given in Chapter-14 of this Particular Specification.

5.5.4 System Expansion

5.5.4.1 The OFC System shall be equipped with sufficient capacities and margins such that the System can operate properly under peak load or traffic conditions.

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

5.5.4.3 The OFC System shall be compatible with SDH Equipment from other manufacturers.

5.5.4.4 The NMS for OFC System shall be designed and equipped with all necessary hardware, software and capacity for future additional SDH Equipment and associated Flexible Access Multiplexers.

G **End of Chapter 5** G

CHAPTER 6 - DATA NETWORKING SYSTEM

6.1 General

6.1.1 An extensive Data Networking System shall be provided for meeting the Packet Data Communications requirements of EDFC Phase-2. Data Networking System which is a Wide Area Network (WAN), shall, inter-alia, cover OCC, Stations, New Bhaupur Station, TSSs, IMDs, and IMSDs.

6.1.2 The Wide Area Network (WAN) shall provide sufficient bandwidth to cater for the Packet Data Communications requirements of various Sub-systems under this Contract as well as under Contract Package CP-204. This Wide Area Network (WAN) shall also provide sufficient bandwidth to cater for the Packet Data Communications requirements of EDFC Phase-2 for other applications such as Freight Operation Information System (FOIS), Crew Management System (CMS) and Wagon Management System (WMS).

6.1.3 All Vital & Safety Related System using Data Networking System shall be implemented as per EN-50159.

6.1.4 Wide Area Network (WAN) shall be a highly reliable system since it shall be the primary means of Packet Data Communications between various locations mentioned above. The System Design shall be highly resilient to Common Mode Failure with least recovery time and shall provide High Performance under normal operation as well as under worst case Network Loading.

6.1.5 Wide Area Network (WAN) shall be created using Layer-3 Switches and Optic Fibre Cable Networks of EDFC Phase-2.

6.1.6 WAN shall comply with internationally recognised Industry Standards & Open System Protocols. The Design of Wide Area Network (WAN) shall provide a highly Secure System, which shall prevent unauthorised Access and/or Hostile Intrusion.

6.1.7 Ethernet Services such as Ethernet Private Line (EPL) Services, Ethernet Virtual Private Line (EVPL) Services and Ethernet Local Area Network (E-LAN) shall be extended to Auto Location Huts, GSM-R Locations, LC Gates, SPs & SSPs using EoS (Ethernet over SDH) of OFC System for meeting the requirements of other Sub-systems within this Contract as well as under Contract Package CP-204.

6.1.8 At Junction Stations & Crossing Stations, Wi-Fi Facility, compliant with IEEE 802.11g Standards shall be provided for WAN Connectivity to users (which also include drivers of passing trains) via Wireless Enabled Devices and Equipment. A minimum of 10 simultaneous users may use the Wi-Fi Connectivity at Stations. This Wi-Fi Facility shall as a minimum cover Station Buildings and EDFC Tracks up to 500 meters in both directions.

6.1.9 Network Management System for Data Networking System to be provided at OCC shall facilitate configuration, administration, monitoring and troubleshooting of the Data Networking System.

6.1.10 Structured Cabling for Data Networking System shall be within the scope of work under this Contract.

6.2 Scope of Supply for Data Networking System

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

(1) Layer-3 Switches;
(2) Layer-2 Switches;
(3) Wi-Fi Access Equipment;
(4) Distribution Frames;
(5) terminating and interconnecting equipment/panels;
(6) equipment cabinets, racks and cubicles;
(7) all type of cables and cords;

(8) all required connectors;
(9) installation materials;
(10) Network Management System;
(11) earthing and accessories including termination protection devices;

6.3 System Requirements

6.3.1 WAN shall be created using Layer-3 Switches equipped with minimum 4 Nos. 10GigE Fibre Ports for backbone interconnections. WAN shall connect OCC, Stations, New Bhaupur Station, IMDs and IMSDs, in Ring Topology using Optic Fibre Cable. Further WAN shall connect TSSs with nearest stations in Redundant Linear Topology using Optic Fibre Cable. Locations of Layer-3 Switches can be clubbed based upon design of other Systems/Subsystems under this Contract as well as under Contract Package CP-204 while meeting overall Packet Data Communication Requirements.

6.3.2 Layer-3 Switches at New Bhaupur Station shall be integrated with Layer-3 Switches being provided at New Bhaupur Station under Contract Package CP-104 using 10GigE Fibre Ports with 1+1 Protection.

6.3.3 Layer-3 Switches at OCC shall be integrated with Layer-3 Switches at OCC being provided under contract Package CP-104 using 10GigE Fibre Ports with 1+1 Protection.

6.3.4 Each Layer-3 Switch Site shall employ, as necessary, Multi-layer Switching comprising a combination of Layer-2 Switching and Layer-3 Protocol Routing. Layer-2 Switch shall be deployed as per Site Requirements. Network Topology and Connectivity Plan shall be submitted as part of Design to the Engineer for approval.

6.3.5 Layer-3 Switch shall be provided in fully duplicated configuration at each site in (1+1) Hot-Standby Configuration.

6.3.6 Layer-3 Switches at New Bhimsen and Mughalsarai shall be equipped with additional 2 Nos. 10GigE Fibre Ports.

6.3.7 WAN shall be of highly Scalable Design, whilst maintaining Throughput, Quality of Service and Security.

6.3.8 Ethernet Services such as Ethernet Private Line (EPL) Services, Ethernet Virtual Private Line (EVPL) Services, Ethernet Local Area Network (E-LAN) Services, Layer2 Protocol Tunnelling (L2PT), Virtual Private Wire Service(VPWS) & Ethernet over MPLS (EoMPLS) shall be available on WAN.

6.3.9 Ethernet Services such as EPL, EVPL & E-LAN shall be extended to Auto Location Huts, GSM-R Locations, LC Gates, SPs & SSPs using EoS (Ethernet over SDH) of OFC System.

6.3.10 EPL, EVPL, E-LAN, L2PT and VPWS Services of EDFC Phase-1 which are to be carried to OCC, shall be carried to OCC using QinQ. EPL, EVPL, E-LAN, L2PT and VPWS Services which are required to be provided across EDFC Phase-1 & EDFC Phase-2 shall be implemented by the Contractor.

6.3.11 Layer-3 Services such as IPv4 Routing, IPv6 Routing, Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), Virtual Router Redundancy Protocol (VRRP)], Multi-Protocol Label Switching, Label Distribution Protocol (LDP), Targeted LDP(T-LDP), Primary & Secondary Label Switched Paths, MPLS L3 VPN, Resource Reservation Protocol (RSVP), MPLS Traffic Engineering (including TE-FRR), Pseudowire LSP Load Sharing, Routed Pseudowire, IP-VPN (RFC 2547/4364) and Integrated Routing & Bridging shall be available on the WAN. These services shall be implemented to cater for the communication requirements of various Sub-systems under this Contract as well as under Contract Package CP-204.

6.3.12 Layer-3 Services of EDFC Phase-1 which are to be carried to OCC, shall be implemented over WAN being provided under this Contract by Contractor

6.3.13 Layer-3 Services IPv4 Routing, IPv6 Routing, BGP, IS-IS, OSPF, VRRP, MPLS, LDP, T-LDP, Primary & Secondary Label Switched Paths, MPLS L3 VPN, RSVP, MPLS Traffic

Engineering (including TE-FRR), Routed Pseudowire, IP-VPN (RFC 2547) and Integrated Routing & Bridging which are required to be provided across EDFC Phase-1 & EDFC Phase-2 shall be implemented by the Contractor.

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

6.3.15 Multicast protocols such as Internet Group Management Protocol (IGMP)/Protocol Independent Multicast (PIM) and (Multicast Source Discovery Protocol) MSDP shall be available on the WAN.

6.3.16 Wide Area Network (WAN) should support IPv4 and IPv6 Protocols. It shall support Static as well as Dynamic Host Configuration Protocol (DHCP) based IP Address Management.

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

6.3.18 Operations, Administration & Maintenance features such as CFM OAM (IEEE 802.1ag), EFM OAM (IEEE802.3ah), MPLS OAM and OAM Functions & Features as per ITU-T Y.1731 shall be available on WAN.

6.3.19 Network Management System shall be provided for WAN. This Graphic User Interface(GUI) based NMS shall have a complete Data Network, so as to provide the necessary control, supervision, maintenance, configuration and performance management. This NMS shall support Layer-2 & Layer-3 Services. This NMS should support following minimum features:

(1) Fault Management & Analysis;
(2) GUI & Service Template based Configuration & Provisioning;
(3) Composite L2/L3 Service Creation & Management;
(4) Performance Statistics collection and management;
(5) Security Management;
(6) OAM Testing;
(7) Troubleshooting and Assurance;
(8) Historical and real-time path monitoring;
(9) Path computation for Network Planning/Traffic Engineering tool integration.

6.4 Performance Requirement

6.4.1 General

Performance requirements for Data Networking System shall be fully complied. This shall be based on fault tolerant design with protections against failure in order to achieve the system availability.

6.4.2 Reliability

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

6.4.2.2 The Contractor shall furnish for the Layer-3 Switch and Layer-2 Switch, the reliability figures such as MTBF in years from the OEMs.

6.4.3 Availability Requirements

6.4.3.1 The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Any degraded mode of operation or re-configuration functions provided by the Data Networking System shall not be included in the determination of the system availability. Contractor shall submit to the Engineer for review and consent the RAMS analysis for the Data Networking System to establish the requirements of availability specified here below.

6.4.3.2 The availability of Data Networking System shall be defined as the availability of the bandwidth between end points of the Data Networking System. The equipment connected for the access for the bandwidth shall be excluded from the availability calculation. The availability Data Networking System shall be better than 99.999%.

6.4.3.3 To improve the availability of Data Networking System various measure such as Resilient Ethernet Protocol, Pseudo wire Redundancy, Link Aggregation (IEEE 802.3ad) on Network/Access Ports, Rapid Spanning Tree Protocol (IEEE 802.1w), Multiple Spanning Tree Protocol (IEEE 802.1s), MPLS-TE Fast Reroute etc. as required shall be implemented.

6.4.3.4 The Network Management System shall be considered unavailable if any functions provided by the Network Management System cannot be properly exercised. The availability of the Network Management System shall be better than 99.5%.

6.4.4 Maintainability Requirements

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

6.4.4.2 The service life of the Data Networking System (equipment) shall not be less than 15 years.

6.4.5 System Safety Requirements

6.4.5.1 In the event of a break in the optical fibre cable, the optical transmitter laser output shall shut down to a safe level as defined by IEC60825, ITU-T G.783, ITU-T G.798. The shutdown mechanism shall not be software dependent.

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

6.4.5.3 Switch shall conform to IEC 60950-1 Standards for safety requirements of IT Equipment.

6.4.5.4 All metallic enclosures shall be provided with an earth terminal

6.5 Technical Requirements

6.5.1 Layer-3 Switches of WAN should meet following minimum technical requirements:

6.5.1.1 Layer-3 Switches of WAN shall have 20 Nos. 10/100/1000 Base-T Auto Sensing Ports with RJ 45 Connectors, 4 Nos. 100/1000 Base-X ports for SFP complying with IEEE 802.3, IEEE 803.3u and 802.3ab standard, and 4 No's of 10G BaseX ports supporting Half Duplex, Full duplex and Auto-Negotiation on each port to optimize bandwidth.

6.5.1.2 Layer-3 Switches shall have minimum of 128 Gbps forwarding bandwidth at Layer-2 and Layer-3 Switching Fabric, a minimum of 32000 MAC address space and 95 million packets (64 Byte packets) per second forwarding rate.

6.5.1.3 Layer-3 Switches shall be capable of working with DC Power Supply with range of -40 to -54V. Power Supply Module shall be redundant field replicable in the switch.

6.5.1.4 All the Layer-3 Switches shall be mounted on a 19-Inch Rack. All accessories required for this mounting shall be supplied by the Contractor.

6.5.1.5 All Software/Hardware/License supplied along with the Layer-3 Switches shall be supplied to the Engineer.

6.5.1.6 Layer-3 Switches shall support features such as Link Aggregation Control (as per IEEE 802.3ad), VLAN on all Ports (IEEE 802.1Q), VLAN Tagging(IEEE 802.1q), Minimum 256 VLANs, Port-Based Authentication(IEEE 802.1x), Spanning Tree Protocol(IEEE 802.1d), Multiple Spanning Tree Protocol(IEEE 802.1s), Rapid Spanning Tree Protocol(IEEE 802.1w), ITU-T G.8032v2, Dynamic Host Configuration Protocol (DHCP), Inter VLAN IP Routing for Layer–3 Routing, IPv6 Routing, Strict Priority Queuing, RADIUS Protocol for console access restriction and authentication as per RFC 2138 and Basic IP Unicast Routing Protocols.

6.5.1.7 Layer-3 Switches shall support multiple privilege level to provide different level of access on console port and telnet sessions.

6.5.1.8 Switches shall support Online Software Reconfiguration to implement changes without rebooting.

6.5.1.9 Layer-3 Switches shall have console port with a RS-232/RJ-45 Interface for configuration and diagnostics purposes.

6.5.1.10 Layer-3 Switches shall support Telnet, SNMP (Simple Network Management Protocol) V1/V2/V3, Network Time Protocol, SSH (Secure Shell) V1/V2 and FTP (File Transfer Protocol).

(1) Timing and Synchronization - ITU-T Sync-E with stratum-3 system clock or IEEE 1588v2 Precision Time Protocol (Slave, Boundary & Transparent clock)
(2) Layer 3 switch should support visibility and flow export with IETF IPFIX format i.e. IPFIX, Net flow v9 etc.

6.5.2 Layer -3 Switch at OCC (Core Switch) shall meet the following minimum technical requirement in addition to the technical requirement mentioned above:

6.5.2.1 Layer-3 Switch (Minimum 2 nos.) at OCC shall have 48 Nos. 10/100/1000 Base-T/100/1000 Base-X Auto Sensing Ports with RJ 45 Connectors/SFP complying with IEEE 802.3, IEEE 803.3u and 802.3ab standard, and 4 No's of 10G BaseX ports supporting Half Duplex, Full duplex and Auto-Negotiation on each port to optimize bandwidth.

6.5.2.2 Layer-3 Switch at OCC shall be chaises based and should have redundant controller, redundant power supply and field replaceable fan trays.

6.5.3 Layer-2 Access Switches shall meet the following minimum technical requirements:

6.5.3.1 Layer-2 Switches of WAN shall have 24 Nos. 10/100 Base-T Auto Sensing Ports with RJ 45 Connectors, complying with IEEE 802.3, IEEE 803.3u and 802.3ab standard, supporting half duplex, full duplex and Auto-Negotiation on each port to optimize bandwidth.

6.5.3.2 Layer-2 Switches shall have minimum of 16 Gbps forwarding bandwidth at Layer-2 Switching Fabric, a minimum of 1,000 MAC address space and 6 million packets (64 Byte packets) per second forwarding rate.

6.5.3.3 Layer-2 Switches shall be capable of working with DC Power Supply with range of -40 to -54V. Power Supply Module shall be redundant and inbuilt/external in/to the switch.

6.5.3.4 All the Layer-2 Switches shall be mounted on a 19-Inch Rack. All accessories required for this mounting shall be supplied by the Contractor.

6.5.3.5 All Software/Hardware/License supplied along with the Layer-2 Switches shall be supplied to the Engineer.

6.5.3.6 Layer-2 Switches shall support features such as VLAN on all Ports (IEEE 802.1Q), VLAN Tagging (IEEE 802.1q) and Minimum 256 VLANs. It shall support centralized VLAN Management, so that VLANs created on the Layer-3 Switches shall be propagated to all other switches automatically.

6.5.3.7 Layer-2 Switches shall support features such as Link Aggregation Control (as per IEEE 802.3ad), Port-Based Authentication (IEEE 802.1x), Spanning Tree Protocol (IEEE 802.1d), Multiple Spanning Tree Protocol (IEEE 802.1s), Rapid Spanning Tree Protocol (IEEE 802.1w), ITU-T G.8032,Dynamic Host Configuration Protocol (DHCP), RADIUS Protocol for console access restriction and authentication as per RFC 2138 and Classification and Scheduling on all ports(IEEE 802.1p).

6.5.3.8 Layer-2 Switches shall Support multiple privilege level to provide different level to provide different level of access on console port and telnet sessions.

6.5.3.9 Switches shall support Online Software Reconfiguration to implement changes without rebooting. .

6.5.3.10 Layer-2 Switches shall support Telnet, SNMP (Simple Network Management Protocol) V1/V2/V3, Network Time Protocol, SSH (Secure Shell) V1/V2 and FTP (File Transfer Protocol).

6.5.3.11 Layer-2 Switches shall have console port with a RS-232/RJ45 Interface for configuration and diagnostics purposes.

6.6 Security

6.6.1 Access Control Mechanisms shall be employed via Authentication, Authorization, and Cryptographic Key Validation, in accordance with IEEE 802.1X, to restrict WAN Access to Authorized Users only. Facilities shall be provided to ensure that the Confidentiality and Integrity of the Data Flows for the WAN cannot be compromised by, for example, Eavesdropping, or Interception and Content Modification.

6.6.2 WAN shall be protected against Malicious Activities on the Networks, including Attacks from Viruses, Denial of Services(DoS), Hacking, Hijacking, Spoofing and other Malicious Events that may compromise the Integrity of the Networks. Such Attacks shall include Sources within as well as outside the WAN.

6.6.3 Network Perimeter Firewall shall be provided to protect WAN against above Malicious Activities/Events from outside the WAN.

6.6.4 The Security Features for Connectivity and Access Control shall include Access Control Lists (ACLs), Authentication, Port-level Security and Identity-based Network Services.

6.6.5 It shall be possible to set individual Levels of Access Rights & Permissions for each User in order to control the Integrity of the Network itself and any Information contained in the Network.

6.6.6 The Contractor shall perform Security Analysis of WAN to demonstrate that all above Network Security Threats has been considered and mitigated.

6.6.7 A 'Global Security Plan' shall be recommended for the WAN including the Procedures to be adopted by the Employer and with the details of the Elements within that Plan.

6.7 Network Resilience and Protection

6.7.1 The Data Networking System shall include, to the extent necessary, the following facilities within the Core Elements of the Design to ensure the requisite Availability of Data Networking System:

(1) Redundant Hardware;
(2) Redundant Network Connections.
(3) Circuit Redundancy & Path Diversity;
(4) No Single Point of Failure.
(5) Recovery from Network Failures
(6) Hot-swap Capability.
(7) Facility for Upgrade of Software & Firmware without any loss of Service.

6.7.2 The WAN System shall remain in Operation and automatically re-configure, if necessary, without the need for Control by the Network Management System, under the fault conditions.

6.7.3 The WAN System shall provide suitable Mechanisms for graceful restart and also for graceful degradation, in which the System shall provide lessened utility or effectiveness in the presence of a Fault, but still manage to provide some Service.

6.8 Network Management System

6.8.1 The Contractor shall provide at each Site, the Local Access to Maintenance Staff to the necessary NMS Functions via a Laptop/Engineers Terminal, equipped with appropriate NMS Software.

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

6.8.3 The Work Station for Network Management, at OCC, shall include a 24 inch colour VDU and high quality colour printing facilities for report generation.

6.9 Structured Cabling

6.9.1 All the Data Circuits from the Switches shall be terminated at the Patch Panel(s) inside the TER for distribution of the internal and external lines and interface with relevant Sub-systems and Project Contractors. All patch panels shall be equipped with proper cable management hardware for neat installation of the cables.

6.9.2 Standard RJ-45 modular socket shall be provided for termination of the Data Circuits for End Users via plug and socket arrangement.

6.9.3 CAT-6e cables shall be used for connection between Patch Panel(s) inside TER to the Standard RJ-45 modular socket

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

G **End of Chapter 6** G

CHAPTER 7 - TELEPHONE SYSTEM

7.1 General

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

7.1.2 The Telephone System shall comprise of Administrative Telephone Network, Direct Line Telephone (DLT) Network, Control Communication System and Emergency Communication System.

7.1.3 Administrative Telephone Network and Direct Line Telephone Network shall be based upon Private Branch Exchange (PBX) for the operation, maintenance and administrative staff to set up voice communication.

7.1.4 Administrative Telephone Network and Direct Line Telephone Network shall be integrated with Administrative Telephone Network and Direct Line Telephone Network respectively provided under Contract Package CP-104 to meet the requirement of this Particular Specification.

7.1.5 Control Communication System shall be provided to meet omnibus voice communication requirement of Traffic Control between OCC and Stations.

7.1.6 Emergency Communication System shall provide an omnibus communication channel between OCC and all Automatic Signals.

7.1.7 Whenever existing equipment are upgraded/augmented to meet the requirement of this Particular Specifications, the available provision for Redundancy in existing equipment shall not be compromised and subsequent to upgradation/augmentation they shall meet the Technical Requirement and Performance Requirement as stipulated in this Particular Specifications.

7.2 Scope of Supply

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

(1) PBX Switches;
(2) IP Telephony Server;
(3) Media Gateways;
(4) Line and Trunk Interfaces;
(5) Direct Line Consoles;
(6) Telephone Sets;
(7) Voice Mail System;
(8) Telephone Network Management System;
(9) Voice Recording System;
(10) Control Communication Equipments;
(11) Emergency Communication Equipments;
(12) Power Supply Equipment, Cables and Accessories; and
(13) Distribution Frames, Cabinets, Enclosures, Racks, etc.

7.3 System Requirement

7.3.1 A highly reliable main and satellite PBXs based Telephone Network shall be installed and commissioned to provide TDM Communications Platform amongst telephone consoles/sets. Main PBX shall be provided at OCC, while Satellite PBXs shall be provided at all Stations. This Network of Main PBX and Satellite PBXs shall be created using 2 Mbps E1 Channels over SDH Network as covered in Chapter-5 of this Particular Specifications. If feasible Contractor may upgrade/augment Main PBX provided at OCC under Contract Package CP-104 to meet the requirements of this Particular Specification.

7.3.2 In addition to PBXs based TDM Telephone Network, IP Telephony Server (Call Server) shall be provided at OCC to provide VOIP based backup Telephony Communication Platform. Media Gateway shall be provided as required to meet the requirement of this Particular Specification. If feasible Contractor may upgrade/augment IP Telephony Server and Media Gateway provided at OCC under Contract Package CP-104 to meet the requirements of this Particular Specification.

7.3.3 The IP Telephony Server shall also have connections with each PBX over Wide Area Network (WAN) as covered in Chapter-6 of this Particular Specification. In case of failure of E1 link(s) between PBXs, all calls shall be routed via IP Telephony Server using IP Link(s) over WAN as an alternate route, without requirement of any manual intervention.

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

7.3.5 **Administrative Telephone Network:**

7.3.5.1 Administrative Telephone Network shall provide voice communication between OCC, Stations, Auto Location Huts, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs, IMDs, IMSDs, Residential Quarters, Guest House and Club/Institute. Approximate requirements of Telephone Sets, which include Analogue Telephones as well as Digital Telephones, are as given in Table below:

SN	PBX Switch Location	Telephone Sets					
		Station Building	Nearby Residential Colonies	Nearby IMD or IMSD	Nearby Service Buildings	Nearby IR Stations	Total PBX Telephones*
1	Mughalsarai	20	5	10	10	10	55
2	New Ahraura Road	20	5	10	10	10	55
3	New Dagmagpur	15	5	10	10	5	45
4	New Mirjapur	15	5	10	10	5	45
5	New Unchdih	15	5	10	10	5	45
6	New Karchana	20	5	10	10	10	55
7	New Manauri	15	5	10	10	5	45
8	New Sujatpur	15	5	10	10	5	45
9	New Rasulabad	15	5	10	10	5	45
10	New Malwan	15	5	10	10	5	45
11	New Kanpur	20	5	10	10	10	55
12	New Bhimsen	20	5	10	10	10	55
13	OCC						32

*The requirement of Telephone Sets at individual location may vary. Exact requirement will be identified during Design Stage.

7.3.5.2 Administrative Telephones to be provided shall be Digital Telephones at OCC(16 Nos.) and at Stations(8 Nos. at each Station). All the remaining telephones shall be Analogue Telephones.

7.3.5.3 In addition to above, 2(Two) IP Video Phones shall be provided at OCC and 1(one) IP Video Phone shall be provided at each Station.

7.3.5.4 The telephones at Stations shall be directly terminated at PBXs, while telephones at locations other than Stations shall be either directly terminated at PBXs (if feasible) or connected to the nearest PBX via the OFC System.

7.3.5.5 The Contractor shall discuss with the Engineer to agree on the exact location of each Telephone Set and IP Video Phone.

7.3.5.6 The Administrative Telephone Network shall provide feature transparency across all the PBXs. The following PBX features shall be provided:

(1)	Automatic Call Back;	(2)	Busy Hunt;
(3)	Break-In;	(4)	Call Forward;
(5)	Call Park;	(6)	Call Party Name & Number Display;
(7)	Call Pickup;	(8)	Call Transfer;
(9)	Call Waiting;	(10)	Conference Call;
(11)	Hot Line;	(12)	Abbreviated Dialling;
(13)	Access Paging;	(14)	Attendant Recall;
(15)	Alternative Route Selection;	(16)	Last Number Redial;
(17)	Line Lockout;	(18)	Malicious Call Trace;
(19)	Recorded Announcement;	(20)	Direct Inward Dialling (DID);
(21)	Direct Outward Dialling	(22)	Distinctive Ringing;
(23)	Last Number Redial	(24)	Music on Hold;
(25)	Speed Dial;	(26)	Voice Mail; and
(27)	Forced Release.		

7.3.5.7 The assignment of the class of service and features to any telephone extension shall be configurable.

7.3.5.8 The Administrative Telephone Network shall support closed homogeneous numbering plan across the network such that the user has to just dial the extension number of the user, he wishes to reach from anywhere in the network. Further this numbering plan of EDFC Phase-2 shall also be homogenous with numbering scheme adopted for EDFC Phase-1 under Contract Package CP-104. The numbering plan shall be discussed with Engineer and implemented only after it is reviewed by Engineer.

7.3.5.9 The Administrative Telephone Network shall support a minimum of the following four levels of programmable restrictions to each telephone extension:

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

7.3.5.10 Analogue Telephone Sets to be provided for Administrative Telephone Network shall be equipped with following facilities:

(1) Handset;
(2) 12 Push-button DTMF Keypad;
(3) On-hook Dialling function;
(4) Display Unit showing Calling and Caller's extension number for Incoming and Outgoing Calls;
(5) 4 Feature Buttons for Redial, Hook-Flash, Mute and Hold;
(6) Hand-Free operation through built-in speaker and microphone; and
(7) Powered by the PBX.

7.3.5.11 Digital Telephone Sets to be provided for Administrative Telephone Network shall be equipped with following facilities:

(1) Handset;
(2) 12 Push-button DTMF keypad;
(3) On-hook Dialling function;
(4) Display Unit showing Calling and Caller's extension number for Incoming and Outgoing Calls;
(5) Ringing Signal Lamp;
(6) Voice Mail Message Lamp;
(7) Hand-Free operation through built-in speaker and microphone;
(8) Adjustable volume control for speaker and ringer;

(9) A minimum of 10 programmable function keys for flexible assignment for; system features or additional extension circuits
(10) Display of call duration;
(11) System Clock Display;
(12) A minimum of 20 Memories for speed dialling; and
(13) Powered by the PBX.

7.3.5.12 IP Video Phones to be provided for Administrative Telephone Network shall be equipped with following facilities:

(1) Handset
(2) On-hook Dialling function;
(3) Hand-Free operation through built-in speaker and microphone;
(4) Adjustable volume control for speaker and ringer;
(5) Display Unit showing Calling and Caller's extension number for Incoming and Outgoing Calls;
(6) Display of call duration;
(7) System Clock Display;
(8) Powered via POE Class 2/3
(9) Support for H.323/SIP
(10) 5" Screen or better for Video
(11) Picture-in-Picture Support;
(12) Integrated Camera with high quality video for video calling;
(13) Automatic low light correction;
(14) Video codec support ITU-T H.263/H.263+/H.264 as a minimum
(15) Video frame rate CIF 30 FPS or better;
(16) 2 RJ-45 10/100/1000BT Ethernet Port POE
(17) Supporting DHCP Client or Static IP Address Allocation Plan;
(18) RTCP and RTP Support;
(19) QoS Support and TOS Diffserv (IEEE 802 1p/q); and
(20) XML Support.

7.3.5.13 The Administrative Telephone Network shall have the capacity of ringing up to minimum of three telephone sets connected in parallel.

7.3.6 A Voice Mail System (VMS) shall be provided and integrated with the PBX Network to enable administrative telephone users to leave, retrieve and broadcast voice messages. Voice Mail shall only be provided to pre-selected groups of staff or telephones. If feasible Contractor may upgrade Voice Mail System (VMS) provided under Contract Package CP-104 to meet the requirements of this Particular Specification.

7.3.7 **Direct Line Telephone Network**

7.3.7.1 The Direct Line Telephone Network shall provide instant, non-blocking & uninterruptible communication between key strategic points, which shall include, but not be limited to:

(1) Train Traffic Control Communication: This is provided for communication with one-touch button selective calling facility between the Traffic Controller in the OCC and Station Controller (SC) at Stations, IR Sectional Control Centres along the DFC Route, Depot Control Rooms, Crew Control Rooms, and other important locations along the route as decided by Engineer, for the control of train movements and effective utilization of section capacity.

(2) Traction Power Control Communication: This is provided for communication with one-touch button selective calling facility between Traction Power Controller in the OCC, Station Controller at Stations, Switching/Feeding Posts of Traction Power to the Overhead Alignment and Maintenance Staff Rooms at wayside locations.

(3) Engineering Control Communication: This is provided for communication with one-touch button selective calling facility between OCC and important Civil Engineering maintenance and work related locations along the track as decided by the Engineer.

(4) S&T Control Communication: This is provided for direct line communication with one-touch button selective calling facility between OCC and important S&T maintenance and work related locations along the track as decided by the Engineer.

(5) between adjacent Station Control Rooms for stations with one-touch button dialling;

(6) between Station Control Rooms of New Bhaupur Station and New Bhimsen stations;

(7) between Station of DFCC and Interfacing Station Master Room of Indian Railway with one-touch button dialling;

(8) between LC Gates and Station Control Rooms of adjacent stations with one-touch button dialling; and

(9) between Depot Control Rooms and Station Control Rooms of adjacent stations with one-touch button dialling.

7.3.7.2 The Direct Line Telephone Network shall be built using PBXs at OCC and Stations. However, PBXs shall have separate extension/line interface cards and separate trunk interface cards to make Direct Line Telephone Network more reliable and non-blocking.

7.3.7.3 Direct Line Network shall facilitate Group Call, Conference Call (with facilities to add additional users (minimum of 6 parties) to an established call) & Emergency Call (with priorities). Direct Line Network shall also facilitate priority level for each category of call.

7.3.7.4 The assignment of the class of service, priority level and features to any Direct Line Telephone extension shall be configurable.

7.3.7.5 Direct Line Console

(1) Direct Line Consoles shall be provided for Assistant Controller and Traffic Controller at OCC and shall have a minimum direct line capacity of 100 lines and shall be capable of interfacing with required direct line extension. The Contractor shall however determine the exact size of each Direct Line Console based on the direct line extensions to be terminated on each Console.

(2) Direct Lines Consoles provided under Contract Package CP-104 for Chief Controller, Deputy Chief Controller, Traction Power Controller, Signalling Fault Management Controller and Track Controller, having a minimum direct line capacity of 100 lines, shall be upgraded/reconfigured to meet the communication requirement mentioned in this Particular Specification, as these controllers are common for EDFC Phase-I and EDFC Phase-II.

(3) Direct Line Consoles shall be provided for Station Controllers in SCR of each Station and shall have a minimum direct line capacity of 30 lines and shall be capable of interfacing with required direct line extensions.

(4) Direct Line Console provided at New Bhaupur Station under Contract Package CP-104 shall be upgraded/reconfigured to meet the communication requirement mentioned in this Particular Specifications.

(5) The Direct Line Console shall be configured as a desktop model/flush mounted in a desk ergonomically matching with the control room furniture.

(6) The Direct Line Console shall provide selection facilities in the form of push button and/or soft keys with visual display unit for user to perform, but not be limited to, the following functions as a minimum:

(a) originate outgoing calls to the selected user;
(b) select and answer any incoming calls destined for the Direct Line Telephone Console;
(c) originate outgoing calls to a pre-defined group of users;

(d) originate outgoing calls to a group or all users defined by the Direct Line Telephone Console at the time before the call is placed;
(e) make conference calls to add additional users to an established call connection;
(f) patch calls or put through two individual users for call connection;
(g) transfer call to PBX extension; and
(h) make and receive emergency call (override facility).

(7) The Direct Line Console shall be equipped with, but not be limited to, the following facilities:

(a) handset;
(b) push button or soft key for each Direct Line Telephone;
(c) 12-push button keypad for dialling;
(d) adjustable volume control for speaker and ringer;
(e) hands-free operation through built-in speaker and microphone;
(f) powered by the Central communications processor;
(g) visual display of details for incoming and outgoing calls;
(h) display of call duration;
(i) system clock display;
(j) lamp for message waiting;
(k) lamp for ringing signal; and
(l) transmit DTMF signal when call has been connected.

(8) The Direct Line Communication System shall support a minimum of 8 simultaneous incoming calls to the Direct Line Console to be queued before these calls are answered. The identity of the calling parties in the queue shall be displayed on the Direct Line Console in ascending order of the incoming sequence. Console Controller shall be able to answer calls in queue in any sequence. Call answered shall be removed immediately from the display.

(9) The selection facilities of the Direct Line Console, in the form of physical push button and/or soft key, shall be labelled with identity of the called party or functions of the selection facilities.

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

(11) Dedicated push button and/or soft keys shall be assigned to each telephone line which can be connected to the Direct Line Telephone/Console.

(12) At least 10 spare push buttons and/or soft keys shall be provided for assignment of additional functions or Console/Telephone.

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

(14) The Direct Line Console shall also be provided with functions for operation as an ordinary telephone set. The Direct Line Console shall be equipped with keypad for dialling to originate administrative telephone network call and support on-hook dialling.

(15) The Direct Line Console shall give different audio and visual indication for normal and emergency calls.

7.3.7.6 Indian Railway Telephone Network shall be integrated with Direct Line Communication System, so that one touch dialling can be done from Direct Line Console to important Operation Locations of Indian Railway as decided by the Engineer.

7.3.7.7 Public Switch Telephone Network (PSTN) Lines shall also be integrated with Direct Line Communication System, so that one touch dialling can be done from Direct Line Console to Electric Power Companies, Emergency Services etc. as decided by the Engineer.

7.3.7.8 Direct Line Telephones

(1) Direct Line Telephone shall be provided in the other locations such as IR Sectional Control Centre, Interfacing Station Master Room of IR, LC Gates, Crew Control Rooms, Depot Control Rooms, Switching/Feeding Posts, TPC Maintenance Staff Rooms, Important Civil Engineering Maintenance & Work related Locations and Important S&T Maintenance & Work related Locations etc., to meet communication requirement as mentioned in Clause 7.3.7.1 above.

(2) These Direct Line Telephones shall have a minimum direct line capacity of 10 lines and shall be capable of interfacing with required direct line extensions. The Contractor shall however determine the exact size of such Direct Line Telephones during the design phase.

(3) Direct Line Telephones provided at SCR of New Bhaupur Station and any other location as required provided under Contract Package CP-104 shall be upgraded/reconfigured to meet the communication requirement mentioned in this Particular Specification.

(4) It shall be possible from Direct Line Telephone to make normal and emergency direct line calls to the designated controllers in OCC. Different audio and visual indications shall be provided for incoming direct line calls on the Direct Line Consoles or Direct Line Telephone for normal and emergency calls.

7.3.7.9 The Contractor shall set up the priority level for Direct Line Consoles/Telephones in consultation with the Engineer.

7.3.7.10 Direct Line Console shall have preset buttons such that by pressing one of these buttons shall immediately connect to the destination.

7.3.8 **Integration of Telephone Networks**

7.3.8.1 Administrative Telephone Network and DLT Network provided under this Contract shall be integrated with Administrative Telephone Network and DLT Network respectively provided under Contract Package CP-104 to meet the requirement of this Particular Specification.

7.3.8.2 After integration, Administrative Telephone Networks shall provide following feature transparency across all the PBXs provided under this Contract as well as under Contract Package CP-104:

(1)	Break-In;	(2)	Call Forward;
(3)	Call Park;	(4)	Call Party Name & Number Display;
(5)	Call Pickup;	(6)	Call Transfer;
(7)	Call Waiting;	(8)	Conference Call;
(9)	Hot Line;	(10)	Abbreviated Dialling;
(11)	Access Paging;	(12)	Attendant Recall;
(13)	Alternative Route Selection;	(14)	Last Number Redial;
(15)	Line Lockout;	(16)	Malicious Call Trace;
(17)	Recorded Announcement;	(18)	Direct Inward Dialling (DID);
(19)	Direct Outward Dialling	(20)	Distinctive Ringing;
(21)	Last Number Redial	(22)	Music on Hold;
(23)	Speed Dial; and	(24)	Voice Mail.

7.3.8.3 After integration functionality as mentioned in Clause 7.3.3 of this Particular Specification shall be available across Administrative Telephones provided under this Contract as well as under Contract Package CP-104.

7.3.8.4 After integration, it shall be possible to make IP Audio & Video calls across IP Video Phones provided under this Contract as well as under Contract Package CP-104.

7.3.8.5 After integration, Direct Line Telephone Network shall provide all functionality as mentioned in Clause 7.3.7 of this Particular Specification across all the Direct Line Consoles/Telephones provided under this Contract as well as under Contract Package CP-104.

7.3.8.6 For above integration, Contractor shall, either provide new PBX, Telephony Server, Media Gateway, Telephone NMS and other associated equipment at OCC and integrate these equipment with PBX, Telephony Servers, Telephone NMS and associated equipment provided at OCC under Contract Package CP-104; **or** upgrade the PBX, Telephony Server, Media Gateway, Telephone NMS and other associated equipment provided at OCC under Contract Package CP-104 to meet the requirement of this Particular Specification.

7.3.8.7 If integration is done by providing new PBX, Telephony Server, Media Gateway and associated equipment at OCC:

(1) PBX provided under this Contract shall be integrated with PBX provided under Contract Package CP-104, through minimum 4 PRI for Administrative Telephone Network and 4 PRI for DLT Network. PBX provided under Contract Package CP-104 shall be suitably upgraded for this integration.

(2) Telephony Server provided under this Contract shall be integrated with Telephony Server provided under Contract Package CP-104, through redundant Data Links allowing maximum simultaneous IP Voice Calls and IP Video Calls across EDFC Phase-I & EDFC Phase-II as per capacity of Telephone Servers & Media Gateways provided under this Contract and under Contract Package CP-104. Telephony Server & Media Gateway provided under Contract Package CP-104 shall be suitably upgraded for this integration.

7.3.8.8 If integration is done by upgrading PBX, Telephony Servers, Telephone NMS and associated equipments provided at OCC under Contract Package CP-104:

(1) Spare PRI available at PBX provided under CP-104 shall not be utilized for meeting the requirements under this Contract.
(2) The Contractor shall be responsible and liable for upgraded PBX, Telephony Server, Media Gateway, Telephone NMS and other associated equipment during Defect Notification Period and during Service Life.

7.3.8.9 The following additional PRI over E1 Link between PBXs provided under this Contract as well as under Contract Package CP-104 shall be provided:

SN	Communication Link
1	New Ekdil-Mugalsarai
2	New Karchana—New Tundla
3	New Kanpur-New Khurja

The PBXs provided at New Ekdil, New Tundla and New Khurja under Contract Package CP-104 shall be upgraded/augmented and reconfigured for providing above PRI over E1 Link. Spare PRI available at PBXs provided at New Ekdil, New Tundla and New Khurja under Contract Package CP-104 shall not be utilized for meeting this requirement.

7.3.9 Voice Recording System (VRS)

7.3.9.1 A centralised Voice Recording System (VRS) shall be provided at OCC to record telephone conversations of all controllers in OCC and Stations. This includes conversation over Direct Line Telephone Network, Control Communication System and Emergency Communication System.

7.3.9.2 A centralised Voice Recording System (VRS) is being provided at OCC, to record telephone conversations of all controllers at OCC and Stations of EDFC Phase-1, under Contract Package CP-104. If feasible, Contractor may upgrade/augment this VRS

provided under Contract Package CP-104 to meet the requirements of this Particular Specifications.

7.3.10 Telephone Network Management System

7.3.10.1 A Network Management System with a workstation, system database, logging printers and mass storage devices shall be provided at the designated place as decided by the Engineer.

7.3.10.2 The Telephone Network Management System has been set up to provide control, supervision and maintenance functions for the Administrative Telephone Network and Direct Line Telephone Network. The following management and administrative functions shall be provided through the use of the centralized maintenance console:

(1) User Data Management;
(2) Fault Monitoring;
(3) Performance Management;
(4) Call Detail Recording;
(5) Voice Detail Recording;
(6) Configuration Management;
(7) Application Program Interface;
(8) Accounting Management;
(9) Maintenance History Management;
(10) System Diagnostics;
(11) Remote Access (RA);
(12) Data Logging;
(13) Remote Alarm Monitoring; and
(14) GUI based Network Topology View.

7.3.10.3 Access to the Telephone Network Management System shall be password protected.

7.3.10.4 Failure in the Telephone Network Management System shall not affect the normal operation of the TDM based PBX Telephony Network or VOIP based Telephony Network.

7.3.11 Control Communication System

7.3.11.1 Control Communication System shall be provided to meet omnibus voice communication requirement of Train Traffic Control.

7.3.11.2 This is provided for communication with one-touch button selective calling facility between the Traffic Controller in the OCC and Station Controller at Stations, IR Sectional Control Centres along the DFC Route, Depot Control Rooms, Crew Control Rooms, and other important locations along the route as decided by the Engineer.

7.3.11.3 Control Communication System shall be provided using Control Communication Equipment as per RDSO Specification No. RDSO/SPN/TC/66/2007.

7.3.12 Emergency Communication System

7.3.12.1 Emergency Control Communication which is an omnibus communication channel terminating at OCC with the Traction Power Controller shall be provided. This Emergency Control Communication shall not have selective calling facility. Emergency Control Communication shall have Emergency Sockets as per IR Standards for RE Areas at all the Automatic Signals to which this omnibus communication channel is terminated. The Portable Telephone of IR Standard for RE Areas, which will be carried by the crew, can be plugged in case of emergency. This Emergency Control Communication channel can be switched to the other controllers by the Traction Power Controller. For better availability, two emergency control communication channel shall be provided, one terminating on the signal posts of Up track and the second one terminating on the signal posts of Down track.

7.3.12.2 Emergency Control Communication up to Automatic Signals shall be extended using Underground Railway Jelly Filled Telecom Quad Cable as per RDSO Specification No. IRS:TC 30-05 with latest amendments.

7.3.12.3 Wherever feasible, Telecom Quad Cable provided for Signalling System under Particular Specification-Signalling Works, shall be utilized for Emergency Control Communication. However, in such cases separate Quad shall be utilized for Emergency Control Communication.

7.4 Performance Specification

7.4.1 General

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

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

7.4.2 Reliability

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

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

(1) Switching Module of the PBXs;
(2) Processor Module of the PBXs;
(3) Memory Module of the PBXs;
(4) Line and Trunk Interface Module of PBXs;
(5) Power Supply Module of PBXs;
(6) Media Gateway;
(7) Direct Line Consoles;
(8) Direct Line Telephones;
(9) Control Communication Equipment; and
(10) Emergency Control Communication Equipment.

7.4.3 Availability Requirements

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

7.4.3.2 The availability of the connection within Administrative Telephone Network shall be better than 99.99%.

7.4.3.3 The availability of the connection within Direct Line Telephone Network shall be better than 99.999%.

7.4.3.4 Voice Recording System, if provided in this phase, shall be considered unavailable under any one or combination of the following conditions:

(1) messages cannot be recorded into the Voice Recording System;
(2) messages cannot be retrieved from the Voice Recording System; and
(3) corruption of voice message stored in the Voice Recording System.

7.4.3.5 The availability of the Voice Recording System shall be better than 99.99%.

7.4.4 Maintainability Requirements

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

7.4.4.2 The service life of the Telephone System (equipment) shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years. Service life shall be counted from the commencement date of the Defects Notification Period.

7.4.5 System Safety Requirements

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

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

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

7.5 Technical Requirement

7.5.1 PBX Network

7.5.1.1 Administrative Telephone Network and Direct Line Telephone Network shall be based upon PBX Network, which shall conform to applicable ITU-T standards.

7.5.1.2 The PBX Network shall offer a fully integrated and transparent digital service acting as a single digital switch.

7.5.1.3 PBXs to be supplied, installed and commissioned for Administrative Telephone Network at stations shall be equipped to, as a minimum and not limited to, the following:

S.N	Description of Item	Stations	OCC
1	Equipped Ports	128	64
2	Wired Ports	224	128
3	Analogue Telephone Ports	96	32
4	Digital Telephones Ports	32	32
5	Ports for CO lines	4	8
6	Ports for DID lines	4	8

7.5.1.4 If a new PBX is not provided at OCC and PBX at OCC provided under Contract Package CP-104 is being upgraded/augmented , it shall be upgraded/augmented for a minimum 32 Analogue Telephone Ports and 32 Digital Telephone Ports and meet the requirements for Administrative Telephone Network to be provided under this Contract.

7.5.1.5 The PBXs shall be additionally equipped with Ports for Direct Line Telephone Network over and above the Equipped Ports mentioned in Clause 7.5.1(3 & 4) above.

7.5.1.6 The PBX Network shall provide non-blocking connection for extension calls within the same PBX.

7.5.1.7 For calls through trunks or tie lines, the Administrative Telephone Network shall provide a GOS of 1% for the following traffic intensity during an average busy hour under normal condition without traffic overflow:

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

7.5.1.8 For calls through trunks or tie lines, Direct Line Telephone Network shall provide Grade of Service (GOS) of 0.1% during an average busy hour under normal condition without traffic overflow.

7.5.1.9 The extension line interface in the exchange equipment shall match the extension equipment as required and fulfil the following requirements :

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

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

7.5.1.10 Redundancy for the important interfaces/modules such as power supply, processor etc. shall be provided.

7.5.1.11 The PBX Network shall be designed such that there is redundancy and diversity in terms of the communication links for call routing and call establishment. This redundancy and diversity shall be applicable for call routing and call establishment across EDFC Phase-1 and EDFC Phase-2.

7.5.1.12 PBXs shall have separate extension cards and separate digital trunk lines for Direct Line Telephone Network to make it more reliable and non-blocking.

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

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

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

7.5.1.16 PBX Network shall be synchronised to the Master Clock signal for merging into a single synchronised network along with the OFC System. The PBX Network shall have internal clock in free running mode in the event of the failure or absence of the Master Clock signal. The slip allowable in the exchange network shall confirm to ITU-T Rec. G.822. A highly resilient telephone network synchronisation scheme shall be developed possibly employing multiple fall back protection and details furnished to the Engineer for review.

7.5.1.17 Each PBX shall be powered by 48 V Battery Back-Up System provided by the Contractor. Surge protection shall be provided in each switch.

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

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

7.5.1.20 The Contractor shall be responsible for reconfiguration of routing table of PBXs being provided under Contract Package CP-104 required to meet the requirement of this Particular Specifications.

7.5.2 VOIP based Telephony Network

7.5.2.1 The VOIP based Telephony Network consists of Call Servers, Media Gateways, IT Network, IP Phones, NMS etc.

7.5.2.2 The Call Servers and Media Gateways of this VOIP based Telephony Network shall be equipped to support 200 IP Voice Phones and 100 IP Video Phones.

7.5.2.3 The Call Server shall have high reliability and there should not be any single point of failure. These Servers shall be provided in (1+1) hot-standby configuration in two different subnets, i.e. if one server fails the second server should provide the complete functionality and be able to take the complete load of the calls automatically without dropping of any existing call.

7.5.2.4 The Media Gateways shall be provided in (1+1) hot-standby configuration. The Media Gateways shall be able to restart automatically without human intervention when the external power supply is resumed after power failure.

7.5.2.5 The IP Video Phones at Stations shall connect to Call Servers over Wide Area Network provided under Chapter-6 of this Particular Specification. Additional layer of POE Switches if required shall be provided.

7.5.2.6 A Unified Messaging Application shall be provided for VOIP based Telephony Network with facilities such as Email, Voice Mail, Faxes, Conferencing & Collaboration(8 Ports) and Inbuilt Soft Phones. The Unified Messaging Application (UMA) shall be accessible from desktop clients and shall support features such as making/receiving calls, sending/replying/forwarding voice messages and recording live conversation. UMA shall have a unified directory that allows the IP Phones and Soft Phones to call by name and identify their correspondents. The UMA shall be equipped to support 300 users.

7.5.2.7 VOIP based Telephony Network shall be synchronized to the Master Clock signal for merging into a single synchronised network.

7.5.2.8 VOIP based Telephony Network shall provide Logical Partitioning to segregate IP to IP, IP to PBX and IP to PSTN calls as per DOT regulations.

7.5.2.9 If integration of VOIP based Telephony Network provided under this Contract and as being provided under Contract Package CP-104 is done by upgrading Telephony Servers, Media Gateways, Unified Mesaging Application(UMA) and associated equipments provided at OCC under Contract Package CP-104, these shall be upgraded for 200 IP Voice Phones, 100 IP Video Phones and 300 UMA Users.

7.5.3 Voice Mail System (VMS)

7.5.3.1 The VMS provided in EDFC Phase-1 shall enable internal and external telephone users to access specific mailboxes using the following peripherals:

(1) analogue telephones using DTMF;
(2) digital telephones;
(3) CO outgoing trunks and DID trunks; and
(4) digital trunk.

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

7.5.3.3 The VMS shall supports 1000 users for 24 hours a day. The system shall be expandable to 2000 users. The ports connecting to the system shall support traffic intensity offered by 1000 users in such a way that 1% GOS shall be achieved. VMS shall provide storage for a total of not less than 240 hours of voice menu and message.

7.5.3.4 If Contractor upgrade/augment Voice Mail System (VMS) being provided under Contract Package CP-104 to meet the requirements of this Particular Specification, it should be upgraded for 1000 Users.

7.5.4 Voice Recording System (VRS)

7.5.4.1 The VRS shall provide recording of stipulated voice conversations over Telephone System and Mobile Train Radio Communication System. It shall be a digital system providing sufficient capacity for recording up to 4 weeks before being overwritten. The VRS shall comply with the requirements as given below.

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

7.5.4.3 The VRS shall be synchronized with the Master clock System. All the recorded telephone conversation shall be date & time stamped with maximum deviation of 2 seconds.

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

7.5.4.5 The VRS shall provide simultaneous recording in both Main and Standby Modules

7.5.4.6 The VRS shall support simultaneous recording and playback without disrupting the on-line recording.

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

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

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

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

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

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

7.5.4.11 The VRS shall comply with the following specifications:

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

7.5.5 Telephone Network Management System

Six Laptops shall be provided for field maintenance. Appropriate software shall be pre-loaded onto the Laptops to access the local maintenance port of the PBX switches for system administration and management.

7.5.6 Block Wiring

7.5.6.1 All the voice circuits from the PBXs shall be terminated at the Main Distribution Frame inside the TER for distribution of the internal and external lines and interface with relevant Subsystems and Project Contractors. The circuit termination shall be of IDC (Insulation Displacement Contact) type.

7.5.6.2 All the data circuits from the PBX shall be terminated at the Digital Distribution Frame inside the TER for distribution of the internal and external lines and interfaces with relevant Subsystems.

7.5.6.3 Multi-core cables shall be provided and connected from the distribution frames inside TER to the distribution frames at the MDF for connection between the PBX and the trunk circuits of PSTN. The interface between the Telephone system and the PSTN circuits shall be at the MDF.

7.5.6.4 Telephone distribution boxes shall be provided and installed at suitable locations for intermediate distribution of the circuits from the PBX switch. The telephone distribution box shall include connection blocks for the circuits termination.

7.5.6.5 Multi-core cables shall be provided and connected from the distribution frames inside TER to the telephone distribution boxes. A minimum spare capacity of 25% shall be reserved in the multi-core cables, distribution frame and the telephone distribution boxes.

7.5.6.6 Standard RJ-11 modular socket shall be provided for termination of the telephones via plug and socket arrangement. The RJ-11 modular socket shall be connected to the nearest telephone distribution boxes to complete the connection between the PBX switch and the telephone.

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

7.5.7 Outdoor Telephone Cable

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

7.5.8 System Expansion

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

7.5.8.2 It shall be possible to provide additional consoles and telephone sets by 25% of installed capacity, in the Direct Line Telephone Network without affecting its performance.

7.5.8.3 Wherever the equipment of Telephone System being provided under Contract Package CP-104 for EDFC Phase-1 is being upgraded/augmented/reconfigured by Contractor, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

GEnd of Chapter 7G

CHAPTER 8 - MOBILE TRAIN RADIO COMMUNICATION SYSTEM REQUIREMENTS

8.1 General

8.1.1 The Contractor shall provide Mobile Train Radio Communication(MTRC) System based on GSM-R for wireless voice and data communication to support the operational and maintenance requirements of EDFC Phase-2.

8.1.2 The system shall be designed based on European Integrated Railway Radio Enhanced Network (EIRENE)'s Functional Requirements Specification (EIRENE FRS v7.3.0) and System Requirements Specification (EIRENE SRS v15.3.0).

8.2 Scope of Work

8.2.1 The Works shall include the survey, design, supply, installation, testing and commissioning of Mobile Train Radio Communication(MTRC) System on EDFC Phase-2.

8.2.2 MTRC System is being provided by Indian Railways in Mughalsarai-Ghaziabad section of Indian Railways(IR). As such in sections, where track alignment of Mughalsarai-New Bhaupur Section of EDFC is running parallel to the existing Mughalsarai-Ghaziabad Section of IRR, Base Station Sub-systems (BSSs) of IR will be shared by DFCCIL. However in sections, where track alignment of Mughalsarai-New Bhaupur Section of EDFC is taking a detour and cannot be served by Base Station Sub-system (BSS) of IR, new BSSs of DFCCIL shall be provided by the Contractor.

8.2.3 It is envisaged that Network Sub-system (NSS) of MTRC System of Indian Railway used for Mughalsarai-Ghaziabad Section shall also be used for MTRC System of EDFC Phase-2. Details of NSS of MTRC System of IR are given in Appendix-II. This NSS shall be upgraded under Contract Package CP-104, if required, to meet the requirements of EDFC Phase-1. This NSS of MTRC System of IR shall be further upgraded, if required, by the Contractor to meet the requirements of EDFC Phase-2.

8.2.4 It is envisaged that all operation and maintenance activities of new Base Station Sub-system (BSSs) of DFCCIL for EDFC Phase-2 shall be managed from Radio Network Management System(Radio NMS) to be provided by Contractor at OCC. Further it is also envisaged that all operational activities of Network Sub-system (NSS) pertaining to EDFC Phase-2 shall be managed from OCC by upgrading the Client Terminal(s) provided under Contract Package CP-104.

8.2.5 Whenever existing equipment of MTRC System of Indian Railway for Ghaziabad-Mughalsarai Section are upgraded/augmented/reconfigured to meet the requirement of this Particular Specifications, the available provision for Redundancy in existing equipment shall not be compromised.

8.2.6 Whenever existing equipment of MTRC System being provided under Contract Package CP-104 are upgraded/augmented/reconfigured to meet the requirement of this Particular Specifications, the available provision for Redundancy in existing equipment shall not be compromised and subsequent to upgradation/augmentation/reconfiguration they shall meet the Technical Requirement and Performance Requirement as stipulated in this Particular Specifications.

8.2.7 Scope of Supplies

8.2.7.1 Scope of supply for the MTRC System shall include, but not limited to the following:

(1) Hardware, firmware, software & licenses required for up-gradation of Network Switching Sub-system (NSS) of Indian Railway to meet the requirement of this Particular Specification;
(2) Hardware, firmware, software & licenses required for up-gradation of Client Terminal(s) provided at OCC under Contract Package-104 for all operational

activities of Network Sub-system (NSS) pertaining to New Bhaupur-Mughalsarai Section of EDFC.

(3) Base Station Controller (BSC) and Radio NMS complete with all hardware, firmware, software & licenses for EDFC Phase-2. If it is possible to upgrade the BSC and Radio NMS provided at OCC under Contract Package CP-104 to meet the requirement of this Particular Specification, Contractor shall upgrade this BSC and Radio NMS duly interfacing with Contractor of Contract Package CP-104.

(4) Hardware, firmware, software & licenses required for up-gradation of TRAU of Indian Railway to meet the requirement of this Particular Specification;

(5) Base Station Transceivers(BTSs) for EDFC Phase-2. It shall include the supply of towers and antennae to be erected near the BTS.

(6) Radio Dispatcher Consoles and associated hardware/accessories, software and licenses;

(7) Cab Radios complete with Power Supply, Battery Pack, Antenna and associated hardware/accessories;

(8) Operational Radios(OPH) & General Purpose Radios(GPH) complete with battery-pack, carry-case and associated accessories;

(9) Lightning Protection Equipment;

(10) Distribution Frames;

(11) Equipment cabinets, racks and cubicles together with mounting brackets and installation material;

(12) Power supplies, cables, connectors, accessories, cabling and earthing for equipment and tower;

(13) All software and license required for operation and maintenance of the MTRC System;

(14) Any other item for fulfilling the requirements of this Contract.

8.2.8 Scope of Services

8.2.8.1 The Contractor shall liaise with WPC for issues of import licence and shall also coordinate in conjunction with DFCCIL with all concerned authorities including WPC, SACFA, Civil Aviation authorities and other local authorities and obtain necessary clearances/sanctions for installation and commissioning of the MTRC System. However, all the documents for this purpose shall be signed by DFCCIL.All License fees shall be paid by DFCCIL

8.3 Functional Requirement

8.3.1 System Services

To meet operational and maintenance requirements, MTRC System shall support the following services based on the EUROPEAN Telecommunication Standards Institute (ETSI), Global System for Mobile (GSM) Standards and additional requirements specified in EIRENE FRS & SRS documents:

(1) voice services:

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

(2) data services:

(a) text message bearer service;
(b) bearer service for automatic fax;
(c) bearer service for train control application;

(3) call related services:

(a) closed user group;
(b) multi-level priority and pre-emption;

(c) advanced call handling, such as call hold, call transfer, call queuing, etc.;
(d) barring incoming or outgoing calls;

(4) railway specific applications:

(a) functional addressing including registration/deregistration by train, engine or functional number;
(b) location dependant addressing;
(c) shunting mode operations;
(d) multiple driver communications within the same train;
(e) railway emergency calls (RECs);

(5) railway specific features:

(a) set-up of urgent or frequent calls through single keystroke or similar;
(b) display of functional identity of calling/called party;
(c) fast and guaranteed call set-up;
(d) seamless communication support for train speeds up to 120 km/h;
(e) automatic and manual test modes with fault indications;
(f) control over mobile network selection; and
(g) control over system configuration.

8.3.2 Coverage and performance

8.3.2.1 The adequate coverage level for a radio installed in a vehicle with an external antenna for at least 95% of the time over 95% of the track along the detours shall be available to meet the system service requirements mentioned above in Clause 8.3.1.

8.3.2.2 The adequate coverage level for an operational radio & general purpose radio at 1.5 meter above ground, for at least 95% of the time over 95% of the following designated areas along the detours shall be available to meet system service requirements mentioned above in Clause 8.3.1.

(1) all station control rooms, level crossing gate huts, equipment rooms, plant rooms, ancillary buildings and any other areas where the operation and maintenance staff may gain entry;

(2) within each depot (IMD, IMSD, Service buildings) area including all rooms, sheds and open area up to the boundaries of the depot;

(3) administrative offices & residential colonies.

(4) 200 metres on both sides from centre of track along Detours.

8.3.3 Call set-up time requirement

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

SN	Call Type	Call Set-Up Time
1	Railway emergency calls	<2s
2	Group calls between drivers in the same area	<5s
3	All operational mobile-to-fixed calls not covered by the above	<5s
4	All operational fixed-to-mobile calls not covered by the above	<7s
5	All operational mobile-to-mobile calls not covered by the above	<10s
6	All low priority calls	<10s

8.3.3.2 The required call set-up times shall be achieved in 95% of cases. Call set-up times for 99% of cases shall not be more than 1.5 times the required call setup time. Set-up times

shall include the time required for any translation of functional numbers internal to the EIRENE network.

8.3.3.3 Emergency calls may use fast call setup procedures. All other calls setup time (except group calls) shall be achieved with authentication procedures enabled.

8.3.4 Handover and Cell Selection

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

8.3.4.2 The call hand-over execution time shall not exceed 300 milliseconds, which is measured from the receipt of 'handover command' to the receipt of 'UA' after 'physical info' on the new channel.

8.3.4.3 The handover success rate shall be at least 99.5% over train routes under design load conditions.

8.3.4.4 The above requirements shall also be applicable when call hand-over is between adjacent RF coverage zones of IR and DFCCIL.

8.3.4.5 The Contractor shall submit details of the hand-over process as a part of the Detailed Design.

8.3.5 Broadcast and Group Call areas

8.3.5.1 Where fixed network users are involved in a group or broadcast call, fixed network users shall be predefined and shall not change during the course of the call.

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

(1) the location of the call initiator (if mobile originated); and

(2) the identity of the group being called (e.g. All users, all trains, etc.).

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

8.3.5.4 The definition of each broadcast or group call area should take into account operational control areas.

8.3.5.5 Mobiles configured for reception of railway emergency calls entering into a call area where a railway emergency call is on-going shall automatically join this call.

8.3.5.6 Cab Radios configured for reception of a call to all drivers in the same area, entering an area where a call to all drivers in the same area is on-going shall automatically join this call unless involved in a higher priority call or involved in a call of the same priority.

8.3.5.7 The Contractor shall be responsible for configuration of broadcast or group call area, over and above configuration already done under Contract Package-104, in consultation with Engineer.

8.3.5.8 The Contractor shall be responsible for configuration of mobiles for emergency calls, over and above configuration already done under Contract Package 104, in consultation with Engineer.

8.3.6 Mobile Equipment

8.3.6.1 Three distinct types of mobile equipment are required. These equipment shall fulfil basic services, facilities and features as specified mandatory in EIRENE FRS v7.3.0 and EIRENE SRS v15.3.0. The Contractor shall provide these mobile radio types:

(1) Cab Radios – for use by the driver of a train and/or by other on-train systems;

(2) Operational Radios (OPH) – for use by railway personnel involved in operations; and

(3) General Purpose Radios (GPH) – for general use by railway personnel involved in trackside maintenance;

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

8.3.6.3 Mobile equipment shall function correctly when travelling at speeds from 0 kmph to 120 kmph.

8.3.6.4 All Mobile Equipment shall be of following power classes:

Radio Type	**Power Class**	**Power (W)**
Cab Radio	2	8
General Purpose Radio (handheld)	4	2
Operational Purpose Radio (handheld)	4	2

8.3.6.5 **Services and Facilities:** Mandatory Requirements as per EIRENE FRS v7.3.0 are mentioned as 'M'. Optional Requirements as per EIRENE FRS v7.3.0 are indicated as Y/N, where 'Y' indicates it is required under this Contract and 'N' indicates it is not required under this Contract.

(1) The following voice telephony services shall be supported for each type of mobile radio equipment.

	Cab Radio	**GPH**	**OPH**
Point-to-point voice calls	M	M	M
Public emergency voice calls	M	M	M
Broadcast voice calls	M	M	M
Group voice calls	M	M	M
Multi-party voice calls	M	Y	Y

(2) The following data applications are to be supported for each type of mobile radio:

	Cab Radio	**GPH**	**OPH**
Text message service	M	M	M
General data applications	M	Y	Y
Automatic fax	Y	N	N
Train control applications	Y	N	Y

(3) The following call related services are to be supported for each type of mobile radio:

	Cab Radio	**GPH**	**OPH**
Display of calling user identity	M	M	M
Display of called user identity	M	M	M
Restriction of display of user identity	Y	Y	Y
EIRENE closed user group	M	Y	M
Call forwarding:	Y	Y	Y
Call hold	M	Y	Y
Call waiting	M	M	M
Display of call charging information	Y	Y	Y

Call barring	M	Y	M
Auto answer service	M	Y	M
Call supervisory information	M	N	Y

(4) The following EIRENE features are to be supported for each type of mobile radio:

	Cab Radio	**GPH**	**OPH**
Functional addressing	M	M	M
Location dependent addressing (section	M	Y	Y
Shunting mode	M	N/A	N
Multiple driver communications within	M	N/A	N/A
Railway emergency calls	M	Y	M

(5) The Contractor shall furnish, as part of the detailed design, full details of the MMIs and each of the functionalities, for all types of mobile equipment listed above.

8.3.7 Cab Radio

8.3.7.1 The Contractor shall supply 5(Five) Sets of Cab Radio with 6 Hrs Battery Back-up under this Contract.

8.3.7.2 The Cab Radio shall facilitate all mandatory functionality as defined in Clause 5.2 of EIRENE FRS v7.3.0. Besides, functionality of (i) register and deregister on-train users; and (ii) run-time diagnostics; shall also be provided in Cab Radio.

8.3.7.3 The driver man-machine interface of Cab Radio shall comprise of the display, control panel, loudspeaker and handset. The driver man-machine interface shall be suitable for viewing in direct sunlight and in darkness.

8.3.7.4 For post incident analysis, all operation speech and data calls of Cab Radio shall be recorded.

8.3.8 General Purpose Radio(GPH)

8.3.8.1 The Contractor shall supply 50(Fifty) Sets of GPH along with Battery Pack under this Contract. Further 50(Fifty) additional Battery Pack for GPH as spares shall be provided under this Contract.

8.3.8.2 The General Purpose Radio shall facilitate all mandatory functionality as defined in Clause 6.2 of EIRENE FRS v7.3.0. Besides, functionality of (i) send/receive emergency calls and (ii) computer interface shall also be provided in General Purpose Radio.

8.3.8.3 The man-machine interface of General Purpose Radio shall comprise of the display, control panel, loudspeaker and microphone. The man-machine interface shall be suitable for use both in day and night.

8.3.9 Operational Radio(OPH)

8.3.9.1 The Contractor shall supply 300(Three Hundred) Sets of Operational Radio (OPH) under this Contract.

8.3.9.2 The Operational Radio shall facilitate all mandatory functionality as defined in Clause 7.2 of EIRENE FRS v7.3.0. Besides, functionality of (i) send/receive emergency calls with facility to enable/disable and (ii) computer interface; shall also be provided in Operational Radio.

8.3.9.3 The man-machine interface of Operational Radio shall comprise of the display, control panel, loudspeaker and microphone. The man-machine interface shall be suitable for use both in day and night.

8.3.9.4 Following accessories shall be supplied along with each Operational Radio

(1) Hands free car kits;
(2) High capacity battery;

(3) Desk top and travel chargers; and
(4) Antenna adapter.

8.3.9.5 For post incident analysis, all operation speech and data calls of Operational Radio shall be recorded.

8.3.9.6 Further 100(One Hundred) additional Battery Pack for Operational Radio (OPH) as spares shall be provided under this Contract.

8.3.10 Radio Dispatcher Console (Controllers Equipment)

8.3.10.1 Following controller positions in OCC shall be provided with Radio Dispatcher Console under this Contract:

S. N.	Description	Number
1	Traffic Controller	2
2	Deployment to be identified later	2

8.3.10.2 Contractor shall also provide one Radio Dispatcher Console at TER in OCC. This shall be used for maintenance purposes.

8.3.10.3 The Radio Dispatcher System being provided at OCC under Contract Package CP-104, will be designed to provide at least 10 additional Radio Dispatcher Consoles. This expansion capacity being provided under Contract Package CP-104 shall not be utilised by Contractor for provision of Dispatcher Consoles required under Clause 8.2.10.1 & 8.2.10.2 of this Particular Specification.

8.3.10.4 The Radio Dispatcher Console shall fulfil basic services, facilities and features as specified mandatory in EIRENE FRS v7.3.0 and EIRENE SRS v15.3.0. The functionalities required by different controllers in Radio Dispatcher Consoles are essentially same, but the control area and their configuration will differ. Radio Dispatcher Consoles shall be provided with following minimum functionalities:

(1) queue all incoming calls or call request showing the functional identity and priority of caller;
(2) emergency call shall be identified and presented on top of all calls in the queue and shown in different colour/flashing followed by calls in order of priority;
(3) allow the controller to select any of the calls from the queue in any order he likes;
(4) allow the controller to establish railway emergency call or railway operation priority call to any mobile by selection from the display;
(5) allow the controller to make, close, enter and leave group calls;
(6) allow the controller to send and receive text messages;
(7) transfer its call to another Radio Dispatcher Consoles;
(8) if a railway emergency call is not answered it shall automatically be transferred to the Chief Controller or any other controller's console as decided by the Engineer; and
(9) The Chief Controller shall have the provision of taking over the functions of any of the Traffic Controllers in their absence.

8.3.10.5 For post incident analysis, all operation speech and data calls of Radio Dispatcher Consoles shall be recorded.

8.3.10.6 It shall be possible for calls to be answered automatically according to incoming call priority.

8.3.10.7 The Contractor shall furnish, as part of the Detailed Design, full details of the MMIs and each of the functionalities of Radio Dispatcher Consoles

8.3.10.8 The Contractor shall be responsible for upgradation (if required) and reconfiguration of Dispatcher Consoles being provided to Controllers in OCC under Contract Package - 104 to include requirement of this Particular Specification, in consultation with Engineer.

8.3.11 Numbering Plan and cell routing

8.3.11.1 The Contractor shall propose numbering plan compliant with EIRENE FRS v7.3.0 and EIRENE SRS v15.3.0.

8.3.11.2 The proposed numbering plan, to the extent possible, shall be consistent with numbering plan of MTRC System of Indian Railway as issued vide RDSO's letter No. STT/WL/MTRC/503 Dated 16.09.2005(Appendix-I).

8.3.11.3 The proposed numbering plan shall be developed over and above the numbering plan developed under Contract Package-104.

8.3.11.4 The proposed numbering plan shall address issue pertaining to interoperability requirements of Cab Radio and other Mobile Equipment between DFCCIL and Indian Railway.

8.3.11.5 The proposed numbering plan shall be submitted to the Engineer for review before implementation.

8.3.12 Allocation of Priorities

8.3.12.1 At least five levels of priority shall be defined. The order of priority for different type of calls shall be implemented with the approval of the Engineer. Cab Radios and the Radio Dispatcher Consoles in OCC shall be configured for priorities for various situations.

8.3.12.2 To ensure interoperability between DFCCIL and Indian Railway, priorities shall be allocated consistently.

8.3.13 Call Restriction

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

8.3.14 Group Membership

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

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

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

(1) Railway Emergency Calls,;

(2) All Train Drivers; and

(3) Shunting Team.

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

8.3.15 Access Matrix

8.3.15.1 The Contractor shall develop the Voice Call Requirement Matrix in consultation with the Engineer and submit the same to the Engineer for review and approval. This Voice Call Requirement Matrix shall be developed over and above Voice Call Requirement Matrix developed under Contract Package CP-104.

8.3.15.2 Voice Call Requirement Matrix shall include additional Controllers Equipment and Mobile Equipment as specified by the Engineer during the execution of the Contract.

8.3.16 Telephone Interconnect Call

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

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

8.3.16.3 Three party conferences between controller, Station Master and Driver/Guard shall be provided.

8.3.16.4 Normally all radio users shall be barred from receiving incoming telephone calls or from making outgoing telephone calls. Designated radio users shall only be allowed the facility of telephone interconnect calls. Telephone interconnects calls from/to unauthorised radio/telephone users shall be rejected. The Contractor shall submit full details in this connection.

8.3.17 All voice communications of Radio Dispatcher Console, Cab Radio and Operation Radio shall be recorded by the Voice Recording System (VRS) being provided under Contract Package-104. The Contractor shall be responsible for upgradation/reconfiguration, if required, of Voice Recording System (VRS) being provided under Contract Package-104.

8.3.18 Radio Network Management System(Radio NMS)

8.3.18.1 The Radio Network Management System shall be a centralised control system with management workstation, system database and mass storage device to be located at OCC.

8.3.18.2 The Contractor shall either supply a new Radio Network Management System or the existing System shall be upgraded for network elements of EDFC Phase-2.

8.3.18.3 The Radio Network Management System shall facilitate all management function mentioned below for Network Elements pertaining to Base Station Sub-systems consisting of Base Station Controllers(BSCs), Base Transceiver Stations(BTSs), TRAU, Interfaces etc. of DFCCIL for New Bhaupur-Mughalsarai Section and Radio Dispatcher Consoles.

8.3.18.4 The purpose of Radio NMS is to provide network management capabilities/features that will assist in efficient management of network. The Radio NMS shall be required with wide range of capabilities and scalability. The Contractor shall deliver a Radio NMS that supports all relevant aspects, including, but not be limited to Fault Management (FM), Performance Management (PM), Configuration Management (CM) and Security Management for all network elements controlled by it.

8.3.18.5 The Radio NMS shall allow users to interact with the system and the network elements controlled by it in a user friendly and efficient way. The Radio NMS applications designed with several hierarchical levels of GUIs, shall have the possibilities to present critical events on all GUI levels.

8.3.18.6 The Contractor shall provide detailed descriptions for all NMS interfaces, including but be not limited to, those for Configuration Management, Fault Management and Performance Management.

8.3.18.7 **Configuration Management**

The NMS shall be provided with a user view of all administrable data stored in each managed Network Element that accurately reflects the actual data stored in the managed Network Element in real or near-real time.

(1) The NMS shall provide the possibility to perform configuration management (addition/changes/deletion), directly and by using command files.

(2) The NMS shall provide the possibility to manage command files (creation/changes/deletion).

(3) The NMS shall provide the possibility to add/change/ delete the configuration data for physical equipment and connections simply by choosing the concerned item (e.g. drop down menu).

(4) In case a user action has an impact on the operational service, a dialog box shall warn the user and give the possibility to cancel the last action.

(5) The NMS shall not allow adding/changing/deleting a connection without verification (end to end consistency check).

8.3.18.8 **Fault Management**

(1) The Radio Network Management System shall provide following fault management functionality.

(a) The NMS shall collect, display and manage alarms and notification with severity level for all the BSS equipment, interfaces and its own equipment;

(b) It shall be possible to define alarms category and severity level and their display shall be customisable;

(c) The alarms and notifications shall indicate the network element in which the event occurred, time, data, level, reason (description) and other important data;

(d) The alarms shall be automatically cleared from the display when impacted equipment is again in nominal service;

(e) User shall have the possibility to easily get information about each displayed alarm and clear or acknowledge a displayed alarm;

(f) All the alarms and notification shall be stored during at least 30 days and it shall be possible to search in the alarm history for certain alarms by filtering on any alarm information;

(g) Information about the state of the network element shall be displayed with the maximum delay of 10 seconds (in respect of the event origination moment).

(2) The following alarm conditions shall be provided to the Radio Network Management System as a minimum:

(a) loss of communication links;
(b) loss of Master Clock synchronisation;
(c) failure of power supply unit;
(d) changeover to redundant central equipment;
(e) base station health status;
(f) central equipment health status;
(g) low power and no power alarms for all transmitters; and
(h) indication of receiver failures.

8.3.18.9 **Performance Management**

(1) The NMS shall provide data concerning the performance of the individual element of BSS and individual channels with respect to traffic volume so as to optimise the system configuration, equipment deployment, user grouping and future sizing of the system.

(2) The NMS shall produce statistical reports on the channel usage and system performance. It shall have the facility to monitor base station channel traffic on real time basis. It shall allow flexible adaption of traffic configurations to the dynamic traffic requirements.

(3) The NMS shall give detailed information about handover (successful / unsuccessful / retry), all type of calls, all type of call drop, traffic and congestion, group calls (successful/failed/cells per GC) etc. These data shall be stored for a

minimum of 1 week. The collected data shall be "transparent" i.e. workable without additional calculation.

8.3.18.10 **Security Management**: As part of the NMS solution the functions related to security is of high importance. Such function(s) shall be provided to avoid and protect against unauthorized access and manipulation in conformance to governing security policy. Some of these required functions are given below:

(1) The NMS equipment shall be protected from access by unauthorized persons and guarantee access to authorized users exclusively according to their respective rights.

(2) Authorized users shall have remote access to NMS systems.

(3) All the actions shall be logged with the associated user, and these data shall be stored at least 1 week.

(4) The access for up to 3 parallel users shall be possible without limitations.

8.3.18.11 **Restoration**: The Network Management System shall provide following restoration features

(1) The NMS shall be equipped with data media capable of storing information to be used for saving the software and settings.

(2) In case of the program failure of any NMS component, restoration of data saved in that medium before the failure shall be ensured.

(3) The Contractor shall precise the NMS data restoration duration for main server and terminal equipment.

(4) The Contractor shall precise the NMS complete system restoration duration for main server and terminal equipment.

8.3.18.12 The NMS shall support integrated trace management function for end to end call tracing. It shall be possible to specify the call to be traced by setting the caller number or called number. It shall be possible to save the result of the tracing to the NMS console for future reference. Any performance limitation related to tracing during live traffic shall be described.

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

8.3.19 Subscriber Management

8.3.19.1 The day-to-day administration, management and control of MTRC System of DFCCIL for New Bhaupur-Mughalsarai section shall be carried out in real-time from OCC through suitable Client Terminal(s) being provided under Contract Package-104.The Contractor shall upgrade existing Client Terminal(s) provided under Contract Package-104 to meet the requirement of this Particular Specification.

8.3.19.2 Some of these functions related to administration, management and control of MTRC System of DFCCIL for New Bhaupur-Mughalsarai section are given below:

(1) configure(create/change/delete) the numbering plan including functional numbering plan;

(2) implement call-barring to prevent uninterrupted access by non-authorized users;

(3) define/configure subscription profiles of mobile equipment;

(4) allocate priorities to calls;

(5) define access class;

(6) implement close user group;

(7) manage of functional numbering i.e. define, modify or remove relationship between Functional Numbers and MSISDN Numbers;

(8) manage the access of mobile equipment to the functional numbering scheme for registration, de-registration and re-registration;

(9) implement forced deregistration;

(10) define the information exchanged between the mobile and network for registration and deregistration;

(11) define, modify or remove relationship between Engine Number and MSISDN;

(12) define routing path using short codes for location dependent addressing;

(13) configure railway emergency group call area;

(14) configuration of Group IDs as per EIRENE FRS v 7.3.0 & SRS v 15.3.0; and

(15) retrieve recorded calls using search criteria.

8.3.19.3 Through these Client Terminal(s) it shall be able to perform configuration management (addition/change/deletion), directly or by using command files. It shall be able to configure data of physical equipment by choosing the concerned equipment from drop-down menu. It shall also be possible able to manage (creation/change/deletion) command files.

8.4 Performance Requirements

8.4.1 General

The following performance requirements for the Radio system shall be complied:

8.4.2 Reliability Requirements

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

(1) MSC sub components
(2) Base Station Controller (BSC)
(3) Base Transceiver Station (BTS)
(4) Radio Network Management System(Radio NMS)
(5) Radio Dispatcher Console (RDC)
(6) Cab Radio
(7) General Purpose Radio (GPH)
(8) Operational Radio (OPH)
(9) Any other equipment forming part of the system.

8.4.3 Availability Requirements

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

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

(1) failure to initiate individual voice call;
(2) failure to initiate voice group call;
(3) failure to initiate railway emergency call;
(4) failure to initiate shunting emergency call;
(5) failure to initiate voice broadcast call;
(6) failure of Location Dependant Addressing;
(7) failure of Functional Addressing;
(8) failure of any one base station causing gap in RF coverage; and
(9) failure of Radio Dispatcher Console unable to receive a call.

8.4.3.3 The MTRC system shall have an overall availability of better than 99.99%.

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

8.4.3.5 Wherever the existing equipment of MTRC System of Indian Railways for Ghaziabad-Mughalsarai Section is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way compromise the reliability, fault tolerance and capacity of supporting non-stop on line call processing.

8.4.3.6 Wherever the equipment of MTRC System being provided under Contract Package-104 for New Khurja-New Bhaupur Section is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way compromise the reliability, fault tolerance and capacity of supporting non-stop on line call processing

8.4.4 Maintainability Requirements

8.4.4.1 Service life of the MTRC system/equipment shall not be less than 15 years.

8.4.5 System Safety Requirements

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

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

8.4.6 Interoperability Requirements

8.4.6.1 Base station subsystem (BSS) being provided under this contract shall comply with the inter-operability requirements for mobile equipment (Cab Radio & Hand Portable as per EIRENE) specifications to be supplied under this contract, in use over Indian Railways and to be supplied for other GSM-R networks of DFCCIL.

8.4.6.2 The mobile equipment (Cab Radio & Hand Portable as per EIRENE)specifications to be supplied under this contract shall comply with the inter-operability requirements with BSS in use over Indian and to be supplied for other GSM-R networks of DFCCIL

8.4.6.3 BSS being provided under this Contract shall be inter operable with Network Sub System (NSS) being provided for WDFC under Contract Package STP-5.

8.5 Technical Requirements

8.5.1 General

8.5.1.1 The MTRC System shall be designed based on European Integrated Railway Radio Enhanced Network (EIRENE)'s Functional Requirements Specification (EIRENE FRS v7.3.0 or latest) and System Requirements Specification (EIRENE SRS v15.3.0 or latest). The main components of the system shall be:

(1) Base Station Sub-system (BSS) of Base Station Controller (BSC) controlling Base Transceivers Stations (BTSs) each containing a number of transceivers (TRXs).

In sections, where track alignment of EDFC Phase-2 is running parallel to the existing Ghaziabad-Mughalsarai Section of Indian Railway, Base Transceivers Stations (BTSs) of Indian Railway will be shared by DFCCIL. Any up-gradation or strengthening required at BTSs of Indian Railway, for smooth handover between BSSs of Indian Railways and DFCCIL, shall be done by the Contractor.

However in sections, where track alignment of EDFC Phase-2 is taking a detour and cannot be served by Base Transceivers Stations (BTSs) of Indian Railway, new Base Transceivers Stations (BTSs) of DFCCIL shall be provided by the Contractor for adequate RF coverage. These BTSs shall be controlled by BSC at OCC. This new Base Station Sub-system (BSS) can be provided either by upgrading and using Base Station Controller (BSC) being provided under Contract

Package CP-104 at OCC to meet the requirements of EDFC Phase-2 or by providing a new Base Station Controller (BSC) at OCC.

This BSC shall be linked to the existing Network Sub-system (NSS) of MTRC System of Indian Railway used for Mughalsarai-Ghaziabad Section. Accordingly BSC and associated network elements constituting the Base Station Sub-system (BSS) shall be compatible with this Network Sub-system (NSS) of MTRC System of Indian Railway used for Mughalsarai-Ghaziabad Section. The Base Station Sub-system (BSS) should fulfil all interoperability criteria with existing Network Sub-system (NSS) of MTRC System of Indian Railway and should be supported with IOT documentation. Base Station Sub-system (BSS) to be provided under this Contract shall be capable of supporting data communications for Train Control System i.e. ETCS Level-2.

(2) Network Sub-system(NSS) containing Mobile Services Switching Centre (MSC) with primary responsibility for call control shall be supported by a Visitor Location Register (VLR) containing temporary details of subscribers active within the MSC area, a Group Call Register (GCR) containing attributes of voice group and broadcast call configurations for the related MSC area, Home Location Register (HLR) holding subscribers details on a permanent basis and IN platform based on CAMEL (Customised Application for Mobile Enhanced Logic).

It is envisaged that Network Sub-systems (NSS) of MTRC System of Indian Railway used for Mughalsarai-Ghaziabad Section shall also be used for MTRC System of EDFC Phase-2. As such Network Sub-system (NSS) of MTRC System of Indian Railway shall be suitably augmented/upgraded by the Contractor to meets the requirements of EDFC Phase-2.

(3) Telephone Interface Equipment to facilitate call between GSM-R Users (RDC, Cab Radio, OPH & GPH) and Telephone System (PBX Network) as covered in Chapter-7 of this Particular Specification.

As Network Sub-system (NSS) of MTRC System of Indian Railway used for Ghaziabad-Mughalsarai Section shall also be used for MTRC System of New Bhaupur–Mughalsarai Section of EDFC, Telephone Interface Equipment provided along with this NSS shall be suitably augmented/upgraded by the Contractor to meet the requirements of New Bhaupur-Mughalsarai Section of EDFC.

(4) Voice Recording System (VRS) interfaced to above Network Sub-systems (NSS) for recording voice communications taking place on RDC, Cab Radio and OPH. All voice communications of Radio Dispatcher Console, Cab Radio and Operation Radio shall be recorded by the Voice Recording System (VRS) being provided under Contract Package CP-104. The Contractor shall be responsible for upgradation/reconfiguration, if required, of Voice Recording System (VRS) being provided under Contract Package CP-104 to meet the requirement of EDFC Phase-2.

(5) Short Message Service Centre (SMSC) interfaced to above Network Sub-systems (NSS) for exchange of text messages. This SMSC is being provided under Contract Package CP-104. The Contractor shall be responsible for upgradation/reconfiguration, if required, of this SMSC being provided under Contract Package CP-104 to meet the requirement of EDFC Phase-2.

a) Mobile equipment which includes Cab Radios, Operation Purpose Handset & General Purpose Handset interfacing to the BSSs.

b) Radio Dispatcher Console provided at OCC.

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

d) Radio Network Management System (Radio NMS) at OCC for managing the Base Station Subsystem(BSS) of New Bhaupur-Mughalsarai Section of EDFC. .

8.5.1.2 Mobile Switching Centre of IR for Ghaziabad-Mughalsarai Section shall be suitably upgraded/augmented for additional capacity of 600 Mobile Equipment (Cab Radio, OPH & GPH) and 6 Radio Dispatcher Consoles. This upgradation/augmentation shall not in any way compromise the reliability, fault tolerance and capacity of supporting non-stop on line call processing.

8.5.1.3 All major equipment and component of the MTRC System being provided under this Contract shall have redundant engineering to minimize the effects of the failure of such equipment to the operations and performance of the MTRC System and in turn meets the Availability Requirements stipulated in Clause of this Particular Specification.

8.5.1.4 Base Station Sub-system (BSS) & Radio Network Management System (Radio NMS) shall be supplied with fault-tolerant architecture to prevent common mode failure so as to ensure continuous operation with minimal loss of facilities in the event of equipment failure.

8.5.1.5 Redundant routing shall be adopted for all fixed telecommunication links and redundant equipment shall be installed within critical components e.g. additional redundant cards.

8.5.1.6 The MTRC System shall support all EIRENE-compliant Mobiles Equipment from different manufacturers.

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

8.5.1.8 The Contractor shall supply the 40 (Forty) GSM-R SIM cards for use with normal GSM mobile sets under this Contract:

8.5.1.9 The Contractor shall submit, as part of the Detailed Design, to the Engineer for review, the full details of all interfaces available at the Cab Radio and Radio Dispatcher Console.

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

(1) all sub-component of Base station System (BSS) including Base Transceiver Station(BTS), Base Station Controller, TRAU etc.;
(2) all sub-component required for upgradation/augmentation of Network Sub-system(NSS);
(3) Radio Network Management System(Radio NMS);
(4) Radio Dispatcher Consoles and associated hardware for OCC;
(5) Cab Radio complete with antenna & MMI;
(6) Operational Purpose Radio (OPH);
(7) General Purpose Radio (GPH);
(8) Antennas of various types;
(9) Subscriber Identification Module (SIM); and
(10) All other equipment, including requirements for interfacing with other sub-systems and other project contractors, forming part of the radio system.

8.5.1.11 All the radios including base stations, hand portable radio and Cab radio shall have a port for field programming and diagnostic access through a Notebook Computer.

8.5.2 Frequency Planning

8.5.2.1 The use of radio frequency (RF) spectrum in India is regulated by the Wireless Planning and Co-ordination (WPC) Wing of the Ministry of Communications, Government of India. MTRC System shall operate within the frequency band of 952.8-954.4/907.8-909.4 MHz. The Employer has been authorised the use of eight frequency pairs in band 952.8-954.4/907.8-909.4 MHz for MTRC System. However, based upon frequency plan

separate clearance for the use of specific frequencies shall be obtained from WPC by the Employer. The Contractor shall provide necessary documentary support for this purpose. The Contractor, if so required by the WPC, shall incorporate specific changes in the frequency plan, after mutual discussions.

8.5.2.2 The Contractor shall prepare a comprehensive frequency plan for MTRC System of New Bhaupur-Mughalsarai Section of EDFC along with MTRC System being provided by Indian Railways in Ghaziabad-Mughalsarai section of Indian Railway. This comprehensive frequency plan shall address issues like overlap, overreach, interference etc. Any upgradation/replacement/shifting/configuration in BTSs of MTRC System being provided by DFCCIL in EDFC Phase-1 or Indian Railways in Ghaziabad-Mughalsarai section for implementation of comprehensive frequency plan shall be carried by the Contractor.

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

8.5.2.4 If after conclusion of Radio Planning it is concluded by the Engineer and the Contractor that additional frequency pairs shall be required; Employer will take necessary action to obtain such additional frequency pairs from WPC. The Contractor shall provide necessary documentary support for this purpose.

8.5.2.5 The system design shall have suitable safeguards to ensure that the operation of a radio set from any other system, except MTRC System of Indian Railway, is debarred, and its operation does not affect the operation of MTRC System of DFCCIL in any way.

8.5.2.6 Frequency planning calculations shall ensure that there will be no interference from frequencies within the systems DFCCIL. RF coverage plots to show that there will be no interference from frequencies within the system shall be submitted to the Engineer for review. In case of interference from other systems outside DFCCIL, the Contractor shall inform the Engineer of such violations and will support the Engineer with necessary data/test results to enable the Employer to address and settle the issue with other systems. Remedial action to overcome the interference, if any required, shall be taken by the Contractor.

8.5.3 Radio Frequency Coverage

8.5.3.1 In sections, where track alignment of New Bhaupur-Mughalsarai Section of EDFC is taking a detour from Bhaupur -Mughalsarai section of Indian Railway and cannot be served by Base Station System (BSS) of Indian Railway, new Base Station System (BSS) of DFCCIL shall be provided by the Contractor.

8.5.3.2 Base Station System (BSS) network shall be planned with an appropriate radio network planning tool and an appropriate propagation model for the terrain being covered. Details of the tool and the methodology adopted shall be submitted to Engineer.

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

8.5.3.4 The coverage level for a radio installed in a vehicle is defined as the field strength at the antenna on the roof of a train (nominally a height of 4m above the track). An isotropic antenna with a gain of 0dBi is assumed.

8.5.3.5 The coverage level for a radio is defined as minimum field strength of downlink available at 4 metre above ground for atleast 95% of the time over 95% of the area. The Gaziabad-Mugalsarai Section of Indian Railways is being provided with minimum coverage level of –95 dbm above Railway Track.

8.5.3.6 The coverage level shall be designed to provide satisfactory indoor and outdoor coverage in detour section for an operational radio and general purpose radio for all areas as specified, including indoor areas for which an extra margin shall be considered. Accordingly minimum coverage level of -78 dbm in outdoor terrain shall be available.

8.5.3.7 The above mentioned signal strength levels are the worst case downlink signal strength level after taking into account all losses such as propagation loss, feeder losses, fading, climatic losses etc.

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

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

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

8.5.3.11 The Contractor shall submit the particulars of locations of radio base station sites, requirements of antenna and aerial support structure (radio towers) necessary to provide the specified area coverage indicating full indoor and outdoor coverage as specified above. The MTRC System shall have tower mounted antennae for wide area coverage.

8.5.3.12 RF signal strength/coverage shall be measured for outdoor as well as indoor areas for down link and results submitted to the Engineer for review as part of System Acceptance Test. To improve the indoor coverage additional measures shall be taken by the Contractor if so required.

8.5.4 System Radio Channel Requirements

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

The MTRC System shall support the following modes of traffic as a minimum:

(1) Normal traffic, this shall be the communication between radios under the RF coverage zone of the same base station.

(2) Inter-base station traffic, this shall be the communication between radios under the RF coverage zones of different base stations.

(3) Emergency traffic shall be the communications during emergency operations.

8.5.4.2 The MTRC system shall as a minimum be equipped with 6 traffic channels, both for voice & data on IR and EDFC routes.

8.5.5 Communication between BTSs and BSC

8.5.5.1 Base Transceiver Stations (BTSs) shall be linked to the BSC through a logical ring network structure, so that link failure on one side shall not affect the availability of the mobile network in any way. All interconnections forming the ring, being BTS-BTS or BTS-BSC shall be realised in a separate geographical/physical route.

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

8.5.6 Cab Radio

8.5.6.1 Cab Radios shall meet all mandatory system requirements as defined in EIRENE SRS v15.3.0. Besides, it shall also meet all system requirements required to comply with this Particular Specification.

8.5.6.2 Cab Radios shall meet all Environmental and Physical requirements as mentioned in Clause 5.7 of EIRENE SRS v15.3.0.

8.5.6.3 Rolling Stock to be equipped with Cab Radio shall have DC Power Supply from 110V Battery Bank with Voltage range of 90V-130V, which will be used for powering up Cab Radios. Power Supply Unit required for conversion of 110 V DC to any other voltage required shall be provided by the Contractor. All wiring/cabling from 110 V DC Power Source to Cab Radio shall be done by the Contractor. Required protection circuits such as Over voltage protection or Short-circuit protection shall be provided by the Contractor.

8.5.6.4 Cab Radio Man-Machine Interface

(1) Cab Radio Man Machine Interface shall comprise of the following components:
- display;
- control panel;
- loudspeaker;
- handset with push –To-Talk button.

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

(3) Layout of the equipment in the cab shall be decided in consultation with the Engineer.

(4) The Cab Radio shall be provided with sufficient filtering and suppression circuit to make it immune to radio interference.

(5) Two identical input power from rolling stock power supply in main and hot standby mode of operation shall feed the cab radio unit. The switchover from the main to hot-standby power supply shall be transparent and not cause any loss in communication to the radio users. The Contractor shall use converters, if required, to power the Cab Radio.

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

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

(8) The driver shall be able to adjust the contrast of the display.

(9) The emergency call button shall be red and shall be protected against accidental use.

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

(11) Display characters shall have a minimum height of 5 mm.

(12) MMI shall be splash proof and suitable for viewing in direct sun light and in darkness.

(13) Cab radio shall prevent tampering.

(14) If contact with the mobile radio network is lost, the cab radio shall give an audio and visual indication.

(15) Driver Man-Machine interface shall be installed in the leading cab and also the trailing cab (if available) of each rolling stock.

(16) Facilities shall be provided to support a list of stored names /numbers of up to a minimum of 100 entries.

(17) Abbreviated dialling facility shall be supported.

8.5.6.5 Built-in Test Routine

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

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

(3) The fault and self-diagnostics information shall be processed and sent to the dispatcher's console (specific RDW to be decided during design) to indicate the

status of the cab radio to facilitate prompt fault diagnosis and enable DFCCIL staff to locate faulty modules for first line replacement.

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

8.5.6.6 Run Time Diagnostics

(1) The cab radio shall be capable of performing a suite of runtime diagnostic tests on all physical interfaces.
(2) Failure of an interface shall be reported to the driver via the display on the MMI indicators.
(3) All failures shall be recorded in the activity log at OCC.
(4) Diagnostic tests shall not interfere with normal operation of the cab radio.

8.5.6.7 Cab Radio Antenna

(1) The antenna shall be mounted suitably on the roof of the rolling stock to meet the required performance specifications without causing any electromagnetic interference to other equipment on board the Train.
(2) The Contractor shall submit the drawings showing the placement of the antenna on the roof of the rolling stock. The low profile antenna on the roof of the rolling stock shall not infringe the schedule of dimensions.
(3) The antenna and mounting brackets shall be extremely rugged low profile design and shall withstand the effects of washing plants, mechanical vibration, dust accumulation and other physical hazards typical of railway environments.
(4) Where applicable, the antenna feed shall consist of pre-terminated, double screened, flexible, 50 Ohm, RF feeder cable. The feeder routing shall be designed to avoid effects of EMI.
(5) The orientation and placement of the antenna on the roof of the rolling stock shall ensure minimum VSWR and maximum coupling of RF signal.
(6) Cab radio antenna shall as a minimum comply with requirements of Shock and vibrations etc. The Contractor shall submit to the Engineer for review complete specifications/OEM's datasheets of cab radio antennas considered in the RF coverage design.
(7) Cab radio antenna shall be separated from other antennas to ensure no desensitization.

8.5.7 Operational Purpose Radio

8.5.7.1 Operational Radios shall meet all mandatory system requirements as defined in EIRENE SRS v15.3.0. Besides, it shall also meet all system requirements required to comply with this Particular Specification.

8.5.7.2 Operational Radios shall meet all Environmental and Physical requirements as mentioned in Clause 7.5 of EIRENE SRS v15.3.0.

8.5.8 General Purpose Radio

8.5.8.1 General Purpose Radios shall meet all mandatory system requirements as defined in EIRENE SRS v15.3.0. Besides, it shall also meet all system requirements required to comply with this Particular Specification.

8.5.8.2 General Purpose Radios shall meet all Environmental and Physical requirements as mentioned in Clause 6.4 of EIRENE SRS v15.3.0.

8.5.9 Antenna Towers at Radio Base Stations

8.5.9.1 The towers shall be designed and constructed for working and installation in the geographical and environmental conditions.

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

8.5.9.3 The towers shall be self-supporting steel structure.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

8.5.10 Base Station Outdoor Antenna

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

8.6 System Expansion

8.6.1 The MTRC System design shall cater for modular expansion at all hardware locations to accommodate future requirements and/or upgrades without the need for replacement of the installed hardware and software during the equipment lifetime. Expansion/up-gradation of the MTRC System shall be possible by addition of modules, cards/sub-racks and additional licenses for additional base stations. The contractor shall submit to the Engineer the expansion capability of various equipment and sub-systems for review.

8.6.2 The equipment installed in the TER at OCC shall meet the requirements of expansion to provide additional capacity of 25%.

8.6.3 Wherever the existing equipment of MTRC System of Indian Railways for Gaziabad-Mugalsarai Section is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

8.6.4 Wherever the equipment of MTRC System being provided under Contract Package CP-104 for EDFC Phase-1 is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

G End of Chapter 8 G

CHAPTER 9 - MASTER CLOCK SYSTEM

9.1 General

9.1.1 The Master Clock System shall provide 'Synchronized Time Information' using Global Positioning System (GPS) as time source.

9.1.2 This Synchronized Time Information shall be used to synchronize slave clocks which shall be located at Stations, Depots & Offices in EDFC Phase-2.

9.1.3 This Synchronized Time Information shall also be provided to other Interfacing Systems/Sub-systems and shall be achieved by means of the Network Time Protocol (NTP).

9.1.4 Master Clock System being provided shall conform to ITU-T Recommendations G.811 and G.812 for the synchronisation timing and timing distribution requirements.

9.2 Scope of Supply for Clock System

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

(1) A Master Clock System;
(2) GPS Receiver and Antenna;
(3) Sub-Master Clocks;
(4) Slave Clocks (Analogue and Digital Clock Display Units);
(5) Clock Management System;
(6) Data & Power Supply Cables including Terminations;
(7) Earthing and Lightning Protection Devices;
(8) Installation, Testing and Commissioning Materials; and
(9) Any other item required to complete the scope of the works.

9.3 System Requirements

9.3.1 The Master Clock System shall be based on a 'Central Master Clock', which shall be synchronised to 'Universal Time Co-ordinated' (UTC) by Radio Signals transmitted via the US Department of Defence's 'Global Positioning System' (GPS) Real Time Navigation Satellites.

9.3.2 A GPS Receiver at OCC/Control Location shall receive the Time Source through a Rooftop Antenna from the satellites of the GPS.

9.3.3 The Time Source shall be sent to a Central Master Clock Unit which shall convert the Time Source to synchronization pulses for the use of the slave clock units. The Central Master Clock Unit shall also distribute the time information to Sub-Master Clocks using NTP by an Ethernet Interface.

9.3.4 At OCC, Station, Depot and Office, a Sub-Master Clock Unit shall receive the time information from the Central Master Clock and shall convert it into synchronization pulses for the slave clock units at those locations.

9.3.5 Slave Clocks shall be connected to the Central Master Clock Unit and the Sub-Master Clock Units. Slave Clocks Schedule is as below:

SN	OCC/Station/Depot	OCC Theatre/SM Room/ Depot Control Room		Building
		Digital	Analogue	Digital
1	Mughalsarai	1	1	6
2	New Ahraura Road	1	1	6
3	New Dagmagpur	1	1	6
4	New Mirjapur	1	1	6
5	New Unchdih	1	1	6
6	New Karchana Jn.	1	1	6
7	New Manauri	1	1	6
8	New Sujatpur	1	1	6
9	New Rasulabad	1	1	6
10	New Malwan	1	1	6
11	New Kanpur	1	1	6
12	New Bhimsen	1	1	6
13	IMD Mughalsarai	1	1	8
14	IMSD New Dagmagpur	0	0	4
15	IMSD New Unchdih	0	0	4
16	IMD New Karchana	1	1	8
17	IMSD New Manauri	0	0	4
18	IMSD New Rasulabad	0	0	4
19	IMSD New Malwan	0	0	4
20	IMD New Kanpur	1	1	8
21	OCC	2	2	10

9.3.6 The Slave Clocks shall be of analogue or digital types. The clock face design shall ensure that these clock units shall provide good visibility.

9.3.7 Each of the Systems/Sub-system that require Synchronized Time Information shall be connected to the OCC or Station LANs and shall obtain the information using NTP from Master Clock System.

9.4 Performance Specifications

9.4.1 General

9.4.1.1 In addition to what has been specified in Chapter 3, the following performance requirements for the Master Clock System shall be complied.

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

9.4.2 Reliability

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

9.4.2.2 The Contractor shall furnish to the Engineer the reliability figures i.e. MTBF Hours from the OEMs of the following sub-systems/equipment:

(1) Master Clock;
(2) Sub-Master Clock; and
(3) GPS Receiver.

9.4.3 Availability Requirements

9.4.3.1 The Contractor shall implement a RAMS Plan defined in accordance with IEC 62278. The Contractor shall submit to the Engineer for review the RAMS analysis for the Master Clock System to establish the requirements of availability specified herein below.

9.4.3.2 The Master Clock System shall be considered unavailable if the clock signal is not available at any location or the accuracy of the clock signal is below the specification. The availability of the Master Clock equipment shall be better than 99.99%.

9.4.3.3 Maintainability Requirements

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

9.4.3.5 The service life of the Master Clock System shall not be less than 15 years.

9.4.3.6 System Safety Requirements

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

9.4.3.8 All metallic enclosures shall be provided with an earth terminal which shall be connected to Earth.

9.5 Technical Requirements

9.5.1 Central Master Clock

9.5.1.1 The Central Master Clock shall consist of Redundant GPS Receivers which shall continuously collect the external time information, e.g. Universal Coordinated Time (UTC) and derive Indian Standard Time by offsetting as required.

9.5.1.2 Antenna of GPS Receiver shall be weather proof. It shall be tolerant to direct sunlight, wind, rain and other sources of water. The Antenna shall be mounted at appropriate location to be identified during design. Surge Protector shall be provided between Antenna and Central Master Clock Units.

9.5.1.3 The GPS receiver shall not suffer from the GPS week counter rollover problems, which cause the week counter to reset to zero every 1024 weeks.

9.5.1.4 To protect the Master Clock equipment from lightning, surge protectors shall be provided to connect from the GPS antenna to the ground to safely shunt potentially damaging voltage on the antenna to the ground.

9.5.1.5 The Central Master Clock shall consist of Redundant Master Clock Units. The Master Clock Units shall detect the absence or corruption of the UTC time standard signal and give an alarm if either of these occurs. Bad data resulting from a satellite malfunction, temporary reception problems or an erroneous upload to satellite is not used. Errant timing that causes errors in the timing system shall be avoided.

9.5.1.6 The Master Clock Units shall have their own oscillator and be able to maintain accurate time with an accuracy of 30 milliseconds w.r.t. GPS Reference for duration of 24 Hours of loss of time synchronization with GPS.

9.5.1.7 The Master Clock Units shall be self-correcting in the event the synchronization from the GPS is lost and re-established.

9.5.1.8 The Central Master Clock Units shall support connectivity of Ethernet TCP/IP Network, RS485 and RS232 as required.

9.5.1.9 The Master Clock Units shall include Network Time Server to provide NTP timing for other interfacing Systems/Subsystems connected to the OCC/Stations/Depot/Office LANs. The type and quantities of the interfaces shall be determined by the interface requirements of the Subsystems under this Contract and relevant Interfacing Project Contractors. Network Time Synchronization over the Data Network using NTP shall be with an accuracy of ±0.01 seconds per 24 hours.

9.5.1.10 Audio and Visual Alarm outputs shall be provided to indicate loss of Time Synchronization or Power.

9.5.2 **Sub Master Clock**

9.5.2.1 The Sub-Master Clock at Station shall be synchronized by the Central Master Clock over NTP. It shall be possible for Sub-Master Clock to work both as NTP Server and NTP Client.

9.5.2.2 The Sub-Master Clock shall be able to detect the absence or abnormality of the synchronized time signal from the Central Master Clock. The Sub-Master Clocks shall have its own internal clock and be able to maintain time with a minimum accuracy of 1s a day when they do not receive signals from the Central Master Clock. On restoration of the Master Clock Signal, the Sub-Master Clock shall validate the signal and after successful validation the Sub-Master Clock shall self-correct if necessary.

9.5.2.3 Local Display of the time shall be provided. Display shall include hours and minutes.

9.5.3 **Display Clocks**

9.5.3.1 All display clocks shall be synchronized by the Central Master Clock Unit//Sub-Master Clocks. The slave clock shall be able to free run from local quartz oscillators with drift of one second per day in the absence of communication link or synchronisation sources.

9.5.3.2 Analogue Slave Clocks for indoor use shall be single sided with minimum dial diameter of 30 cm, with minimum viewing distance of 30 metre.

9.5.3.3 Digital Slave Clocks for indoor use shall be 7 Segments LED type with minimum digit height of 57 mm, with minimum viewing distance of 20 meter.

9.5.3.4 The displayed time of all display clocks shall be hours and minutes.

9.5.3.5 The display shall be clear under relevant, frequently occurring lighting conditions, including direct sunlight (from behind and in front) and when there are any reflections in the clock faces.

9.5.3.6 The optical characteristics of the transparent display cover shall be selected such that the light transmission and display contrast are suitable for the environment in which the clocks are installed.

9.5.3.7 Subject to the architectural constraints for each specific location, the clocks shall either be wall mounted or ceiling mounted or pole mounted. The Contractor shall determine the mounting method and submit to the Engineer for review before installation.

9.5.3.8 The Slave Clocks shall be manufactured to be used in non-air-conditioned environment with high humidity exposure.

9.5.3.9 The Master Clock System shall be capable of working from 230 Volts +/- 10% AC 50 Hz Power Supply.

9.5.4 **Clock Management System**

9.5.4.1 The status of the Master Clock Systems including GPS Receiving System, Master Clock Units, Clock Distribution System, NTP Servers, Sub-Master Clocks and Slave Clocks shall be monitored using SNMP by proposed dedicated Clock Management System to be provided at OCC.

9.5.4.2 The Clock Management System shall provide full configuration support for Master Clock Units and Sub-Master Clocks.

9.6 System Expansion

9.6.1 The Master Clock System shall be equipped with capacity to provide clock signal and timing reference distribution to 50 additional locations for other System/Subsystem or Sub Master Clocks.

9.6.2 The system shall be able to support the required number of display clocks plus at least 10 additional Slave Clocks at each location.

G End of Chapter 9 G

CHAPTER 10 - VHF COMMUNICATION SYSTEM

10.1 25 Watt VHF Transceivers

10.1.1 General

10.1.1.1 Specifications given below shall be read in conjunction with RDSO Specification No. RDSO/SPN/TC/73/2008.

10.1.1.2 VHF Communication System shall be created at Stations using 25 Watt VHF Transceivers. VHF Transceivers along with Power Supply and Associated Accessories & Cables shall be supplied by the Contractor.

10.1.1.3 25 Watt VHF Transceivers shall be installed in Station Control Room and any other specified place as decided by the Engineer. Omni-Directional Antenna for 25 Watt VHF Transceivers shall be mounted on a suitable Pole/Mast at a height of 15 meters from the ground level. Omni-Directional Antenna and Pole/Mast shall be supplied by the Contractor.

10.1.1.4 Provision of Voice Recording of conversation taking place on 25 Watt VHF Transceivers shall be provided through Voice Recording Equipment. This recording shall be Date and Time Stamped along with Stamping of Station Identity and VHF Channel Identity. Storage of Voice Communication shall follow FIFO (First-In-First-Out) methodology. Once voice communication is stored, it shall not get corrupted in any way. There shall not be any compression of the Voice Signals. The capacity of Voice Storage shall be at least 4 -weeks. There shall be an Ethernet Interface Port through which Recorded Voice can be transferred to Laptop for replay or taking backup on CD/DVD. It shall be able to replay the Voice Recordings by simple operation of some feature/function key.

10.1.1.5 48 V DC Battery Backup System under Chapter-11 shall be used as a Power Source for these 25 Watt VHF sets.

10.1.1.6 Device for protection of 25 watt VHF Transceivers base station shall be provided in accordance with RDSO Specification No. RDSO/SPN/TC/98/2011 for Surge Protective Devices for Telecommunication Equipment Specification of 25 Watt VHF Transceivers shall be as given below:

General		
1.	Frequency Range	146-174 MHz
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz or 25 KHz
4.	Frequency spread	28 MHz
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	8K5OF3E or 16KOF3E
7.	Type of Operation	Simplex/Semi Duplex, press to talk with built in condenser microphone and the speaker.
8.	Type of Antenna	Stacked Dipole Omni directional antenna complete with cable and other accessories.
9.	Speaker Impedance	8 Ω
10.	Speaker	Internal Speaker as well as Socket for External Speaker shall be provided (The Internal Speaker shall be cut-off when External Speaker is used).

11.	Output Impedance	50 Ω
12	Protection	Reverse Polarity protection shall be provided. The final transistor shall be protected against high VSWR
Transmitter		
1.	RF Power output	10 to 25W
2.	Frequency Deviation	+/- 2.5 KHz (N type) +/-5 KHz (W Type)
3.	Modulation Sensitivity	80mV for 60% max. deviation at 1000 Hz
4.	Modulation Distortion	Better than 5%
5.	Modulation Fidelity	Within +1, -3 dB of 6 dB/Octave
6.	Spurious & Harmonics supersession	Better than -36 dBm (0.25 µW)
Receiver		
1.	Sensitivity	0.30µV/-118 dBm at 12 dB SINAD
2.	Squelch Sensitivity	Better than -119 dBm
3.	Selectivity	Better than 60 dB
4.	Image and Spurious Rejection	Better than 65 dB
5.	Audio Output	1W with less than 5% distortion at 1 KHz reference measured at specified audio frequency output.
6.	Audio Frequency Response	Within +1, -3dB of 6dB/Octave
Feature-wise Configurations		
1.	Simple press to talk	
2.	Protection against high VSWR	
3.	Channel spacing (12.5KHz) or 25 KHz	
4.	PTT ID Encode	
5.	CTCSS/DCS Signalling alongwith Inverse Scrambling	
6.	Busy Channel Lockout	
7.	Channel scanning with call quieting facility	
8.	DTMF/ Signalling with Selective Calling	
9.	Selective Call Decode.	
10.	Capable of being killed/Unkilled.	

10.2 5 Watt VHF Walkie-Talkie Sets

10.2.1 The Contractor shall supply 200 Nos. 5 Watt VHF Walkie-Talkie Sets complete with their standard OEM Battery Packs, Carrying Case and Charger.

10.2.2 The Contractor shall also supply 15 Nos. Multi-Unit Charger (for charging minimum 5 units) for charging of 5 Watt VHF Walkie-Talkie Sets. The Charger shall be Rapid Battery Charger.

10.2.3 The 5 Watt Walkie Talkie equipment shall be provided as per the following specification or better:

General		
1.	Frequency Range	146-174 MHz (Full Band)
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz or 25 KHz
4.	Frequency spread	28 MHz
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	8K5OF3E or 16KOF3E
7.	Type of Operation	Simplex/Semi-duplex, press to talk with built in condenser microphone and speaker
8.	Type of Antenna	Helical Antenna suitable for Frequency Range specified.
9.	Speaker Impedance	8 Ω
10.	Speaker	Internal Speaker as well as Socket for External Speaker shall be provided (The Internal Speaker shall be cut-off when External Speaker is used).
11.	Output Impedance	50 Ω
12	Protection	(i) Reverse Polarity protection shall be provided. (ii) The final transistor shall be protected against high VSWR
13.	Power Source	2000 mAH 7.2-7.4 V, NiMH or Li-Ion Battery.
14.	Weight	600 g Maximum with Battery.
Transmitter		
1.	RF Power output	1-5 Watt RF power output switch able/ programmable
2.	Frequency Deviation	+/- 2.5 KHz Max. (N Type), +/- 5 KHz (W Type).
3.	Modulation Sensitivity	80mV for 60% max. deviation at 1000 Hz
4.	Modulation Distortion	Better than 5%
5.	Modulation Fidelity	Within +1, -3 dB of 6 dB/Octave
6.	Spurious & Harmonics supersession	Better than-36 dBm (0.25 µW)

7.	VSWR	Less than 1.5
Receiver		
1.	Sensitivity	0.3µV/-118 dBm at 12 dB SINAD
2.	Squelch Sensitivity	0.25 micro V or better at threshold.
3.	Selectivity	Better than 60 dB
4.	Image Rejection	Better than 65 dB
5.	Audio Output	Better than 250mW with less than 5% distortion at 1 KHz reference measured at specified AF output.
6.	Audio Frequency Response	Within +1, -3 dB of 6dB/ Octave
Feature-wise Configurations		
1.	Simple Press-to-Talk	
2.	Protection against high VSWR	
3.	Low Battery Alert	
4.	Capable of VOX for Hands-free Operation.	
5.	PTT ID Encode	
6.	CTCSS/DCS alongwith Inverse Scrambling	
7.	Busy Channel Lockout	
8.	Channel Scanning with Call Quieting facility	
9.	DTMF Signalling with Selective Calling	
10.	Selective Call Decode.	
11.	Capable of being killed/Unkilled.	

10.3 General Requirements

10.3.1 All equipment shall be suitable for operation in the following environmental conditions.

Operating Temperature Range	:	-5° C to +55° C
Storage Temperature Range	:	-10° C to +70° C
Relative Humidity	:	95% Max +40° C non condensing.

Environmental Test Reports in respect of main equipment of 25 Watt VHF Transceivers and 5 Watt VHF Walkie-Talkie Sets proposed to be supplied shall be submitted along with Design Submissions for review by the Engineer. Environmental conditions prevailing in the section where it is to be deployed have been listed in GS – Part 2, Section VI,Volume 1. The Contractor shall submit the Environmental Test Reports to the Engineer for review.

S No	Test	Conditions of test to be conducted as per ISO-9000	
a)	Dry Test	Part-III/SEC.5/1977	55^{o} C(+/-) 2^{o} C. RH<50% Duration 16 Hr.
b)	Dump Heat (Cyclic) Test	Part-V/SEC.2/Variant1/1981	40^{o}C(+/-) 2^{o} C, RH 95%. Two cycles of 24 (12+12) hrs each.
c)	Cold Test	Part-II/SEC. 4/1977	(-)10^{o} C +/-3^{o} C, Duration 16 Hrs.
d)	Drop test (in packed	Part-VII/SEC.3/1979	Six drops one on each face, Height of all 1000mm in case of hand held items and 500mm in case of 0ther items.
e)	Vibration Test	Part VIII/1981	12 Hrs, 4 hours along each axis, at 15-150 Hz and with amplitude of 0.15 mm/2g
f)	Storage Test	Part III/SEC.5/1977 & Part II/SEC.4/1977	-10^{o} C for 5 hours. Then raise the temperature to 70^{o} C for 16 hrs.
g)	Bump test	Part VII/SEC.2/1979	4000 bumps at peak acceleration of 400m/s.sq.

10.3.2 Environmental Test Report with equivalent or superior conditions would be acceptable.

10.3.3 In case of Transceivers, the functional tests shall be carried out at the commencement and at the conclusion of the environmental test sequence as above. The functional tests and permissible degradation shall be as under:

(1) RF Power output : It shall not degrade by more than 1 dB
(2) Receiver Sensitivity : It shall not degrade by more than 1 dB
(3) Frequency Stability : No degradation shall be noticed on any frequency.

10.3.4 In the case of batteries, battery chargers and power supplies, the functional tests shall be carried out at the conclusion of the environmental test sequence as above. The functional tests and permissible degradation shall be as under:

(1) Battery: No degradation in battery capacity
(2) Battery Charger: No degradation in output voltage.
(3) Power Supplies: No degradation in output Voltage.

*** End of chapter 10 ***

CHAPTER 11 - 48 V DC BATTERY BACKUP SYSTEM REQUIREMENTS

11.1 General

11.1.1 The 48 V DC Battery Backup System at each TER, shall be sized to power its full load including, but not limited to, Mobile Train Radio System, VHF Communication System, Telephone System,, Data Networking System and OFC System. The VHF Communication System shall work on 12 V DC.

11.1.2 230 V AC Power Supply for 48 V DC Battery Backup System shall be provided as detailed in Clause 12.3.4 of this Particular Specification.

11.1.3 The Battery Backup System shall include Line Protecting Devices, Battery Chargers, Battery Banks and Load Distribution Arrangement. The Battery Banks shall consist of Valve Regulated Lead Acid Maintenance Free Cells.

11.2 Design Requirements

11.2.1 Design shall take into consideration the voltage drop between the Power Supply Source and the Telecommunication System Load individually at each location (OCC, Stations, Auto Signal Locations, GSM-R Locations etc.).

11.2.2 Provision of suitable Earth Leakage Detector and Alarms shall be made individually at each location (OCC, Stations, Auto Location Huts, GSM-R Locations, LC Gate Locations, etc.).

11.3 Technical Requirements

11.3.1 For high availability, the Battery Backup System at each location shall include 2x100% SMPS based 48 V Battery Chargers in Load Sharing Mode with individual 48 V Battery Bank for each Battery Charger.

11.3.2 Each of the two Battery Banks shall provide busy hour reserve of four(4) hours, for all Telecommunication Equipment powered by 48 V DC Battery Backup System, at each location (OCC, Station, Auto Signal Location, LC Gate Location, etc.).

11.3.3 For sizing the battery capacity at each location, relevant factors like K Factor (as applicable), Ageing Factor (1.25), Design Margin (1.1), Temperature Factor and ECV (as applicable for the type of battery) shall be considered. In addition spare capacity of 25% shall be provided to cater for any requirement of additional equipment at that location.

11.3.4 Battery Chargers shall be as per RDSO Specifications RDSO/SPN/TL/23/99 Version 4.0 with Latest Amendments. Each Charger system shall be sized to meet full load as mentioned above and simultaneously charge the fully discharged Battery Bank connected to it at 10 Hour Rate of Charge for the battery. The Battery Chargers shall be procured from RDSO Approved Sources only. The design shall ensure that the failure of a single component does not cause failure of the 48 V DC Battery Backup System.

11.3.5 All Battery Cells shall be of the Valve Regulated Lead Acid Maintenance Free type to RDSO specifications IRS S93-96 with Latest Amendments for capacities up to and including 500 AH and to TEC Specifications No.GR/BAT-01/03 March 2004 with Latest Amendments for capacities beyond 500 AH. The life of these Battery Cells shall not be less than 7 years.

11.3.6 There shall be no break in the 48 V DC Power Supply to the Telecommunication Systems during failure of one of the Battery Charger with Battery Bank.

11.3.7 The following data shall apply to 48 V DC Battery Backup System:

(1) Input Voltage Range (Single phase): 230 V AC (+10 %, - 20%)
(2) Input frequency: 50 Hz +/- 5%
(3) Output Current: As required for each location

11.3.8 Battery Backup System functions shall include:

(1) Low Voltage Battery Disconnection (LVD)
(2) Battery Disconnection Pre-Alarm
(3) Battery Current Limiting
(4) Temperature Compensated Charging
(5) Test Mode Facility

11.3.9 System Protection shall include

(1) High Voltage Input Disconnection (HVD)
(2) Lightning Protection/Surge Protection
(3) Transient Absorbers for Component Protection
(4) Load Fuses/MCB's as required
(5) Battery Fuses /MCB's as required

11.3.10 Alarms for the Battery Backup System shall be implemented through Network Management System (NMS) provided in EDFC Phase-1 in the TER at OCC.. Contractor shall extend these alarms using appropriate interface such as RS-232, RS-485, TCP/IP etc. Following Alarms shall be provided on the NMS in the TER at OCC for each of the 48 V DC Battery Backup System at all locations.

(1) Mains Available/Mains Not Available
(2) Mains Out of Range
(3) Float Mode
(4) Charge Mode
(5) System Overload
(6) Rectifier Modules Fail (one or more than one)
(7) Battery Cut-Off Pre-Alarm
(8) Battery Fail/Isolated

G **End of Chapter 11** G

CHAPTER 12 - INSTALLATION, EARTHING, LIGHTNING AND SURGE PROTECTION

12.1 General

12.1.1 The Contractor shall supervise all installation of the Works and shall ensure all technical, safety and quality matters adhered to the Design reviewed by the Engineer.

12.1.2 The Contractor shall take every precaution to protect existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment.

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

12.1.4 The Contractor shall ensure his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

12.1.5 The Contractor shall carry out site surveys to ensure sufficient knowledge on the Site before submitting the relevant installation design & drawings and other installation related submissions to the Engineer for review.

12.1.6 The Contractor shall submit calculations, if required, by the Engineer to demonstrate that the proposed mounting methods are sufficient to withstand the wind loading for the equipment. All submitted calculations shall be undertaken and certified by relevant Registered Structural Engineer

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

12.1.8 The installation method statement shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.

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

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

12.1.11 The Contractor shall carry out regular site audit on both technical and safety matters and maintain records of the site audits. The Contractor shall make these records available to the Engineer for inspection upon request.

12.2 Installation Programme

12.2.1 The Contractor shall submit the Installation Programme for review by the Engineer. This Installation Programme shall take into account the following:

(1) Installation schedule
(2) Milestones
(3) Site Access
(4) Interfacing with relevant Project Contractors
(5) Interfacing with Indian Railway at the junction stations.

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

12.2.3 The Contractor shall highlight in his Installation Programme any items, materials, equipment, resources and supports to be provided by the Engineer with dates, duration and location.

12.2.4 The Contractor shall highlight in his Installation Programme all relevant constraints, which may affect the Installation Programme, for the Engineer's attention.

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

12.2.6 The Contractor shall ensure sufficient floats or slacks in all activities and avoid critical paths built in his Installation Programme. In case critical paths cannot be avoided, the Contractor shall take adequate measures to complete all critical paths activities in time and also highlight these critical paths for the Engineer's attention.

12.2.7 The Contractor shall propose contingency plan to ensure all the milestones can be met in case there is slippage in the installation activities.

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

12.3 Installation Works in Equipment Rooms

12.3.1 Telecommunication Equipment Room at Stations, IMDs, IMSDs, Residential Colonies, Club/Institute and Guest House will be constructed by CST Contractor to install the Telecommunication Equipment.

12.3.2 Telecom Power Supply Equipment Rooms at Stations, IMDs, IMSDs, Residential Colonies, Club/Institute and Guest House will be constructed by CST Contractor to install the Telecom Power Supply Equipment.

12.3.3 Telecommunication Equipment Room/Telecom Power Supply Equipment Room at Auto Location Huts, Interfacing IR Stations, GSM-R Locations, TSSs, SPs, SSPs and any other location as required shall be constructed by Contractor as stipulated in Particular Specifications-Building & Structure Works. These rooms shall be preferably be co-located with the Signalling Equipment Room/Signalling Power Supply Equipment Room. At these co-located locations a common S&T Power Supply Equipment Room for housing Signalling Power Supply Equipment as well as Telecom Power Supply Equipment shall be provided with the approval of the Engineer.

12.3.4 Electric Power for Telecom System upto Main AC Distribution Panel common for Signalling & Telecom Systems shall be drawn as covered in Clause 5.3.10 of Particular Specification for Signalling Works. From this Main AC Distribution Panel, electric power for Telecom System shall be taken to Telecom AC Distribution Panel for distribution to Telecom Power Supply Equipment and Telecom Equipment.

12.3.5 48V DC Power Supply from 48 V DC Battery Backup System shall be taken to DC Distribution Panel for further distribution to Telecom Equipment.

12.3.6 Provision of Lighting, Power Outlets, Fans, Ventilator and Air-Circulation shall be made in accordance with Interface Requirements as mentioned in Chapter-10 of General Specification.

12.3.7 All floor-mounted equipment cabinets at the equipment rooms shall be securely bolted to floor/ground, properly aligned and levelled.

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

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

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

12.3.11 All cable and wires inside the cabinets shall be housed in appropriate cable conduits or tied neatly along the side of cabinets. They shall not cause any obstruction to the access of equipment within.

12.3.12 All optical cable fibres which run outside shall be contained in protective conduits.

12.3.13 Portable Fire Extinguishers shall be provided in Telecom Equipment Room and Telecom Power Supply Equipment Rooms. Portable fire extinguishers shall be compliant to NFPA 10 standard and suitable for electrical equipment.

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

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

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

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

(4) equipment mounting and installation methods;

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

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

(7) cable route diagrams for cables within each equipment room.

12.3.15 Installation works inside the equipment rooms shall be carried only after these submissions have been reviewed without objection by the Engineer.

12.4 Installation Works within Buildings

12.4.1 The Contractor shall provide all necessary mounting brackets and accessories for installation of all indoor Telecommunication Equipment as covered in this Particular Specification.

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

12.4.3 All the cable trays/trunks/conduits for cable laying between equipment rooms and indoor Telecommunication equipment shall be provided by the Contractor. The size of trays/trunks/conduits shall be so selected to ensure that cables shall not occupy cross-sectional space in excess of 50%.

12.4.4 After conduits have been laid, they shall be thoroughly cleaned by a mandrel of diameter slightly less than the conduits being drawn through. Subsequently a draw wire of galvanized steel shall be left in each conduit to facilitate the drawing of cables. The conduits ends shall be sealed temporarily to prevent the entry of foreign matter.

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

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

(2) equipment mounting and installation methods;

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

(4) cable trays/trunks/conduits route plan within building showing cross-sectional occupancy; and

(5) cable route diagrams for cable within buildings.

12.4.6 Installation works within the building shall be carried only after these submissions have been reviewed without objection by the Engineer.

12.5 Outdoor Installation Works

12.5.1 The Contractor shall provide all necessary mounting brackets and accessories for installation of all outdoor Telecommunication equipment as covered in this Particular Specification.

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

12.5.3 All the cable ducts/troughs/trenches or cable trays/trunks/conduits for cable laying between equipment rooms and outdoor Telecommunication equipment shall be provided by the Contractor.

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

(1) specifications, sample of all the mounting brackets and accessories;
(2) equipment mounting and installation methods; and
(3) schematic diagrams and wiring diagrams of the System.

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

12.5.6 All trackside equipment and the mounting method shall be designed in the way to minimise the frequency of preventive maintenance.

12.6 Cab Radio Installation

12.6.1 Cab Radio to be installed in rolling stocks shall be identified by Engineer and informed to Contractor during Design Stage.

12.6.2 The mounting of the Cab Radio and its sub-assemblies shall be designed to facilitate ease of maintenance.

12.6.3 All cabling and termination shall adopt standard wiring practice.

12.6.4 Cab Radio installation shall be rugged and capable of withstanding vibrations expected in such type of EMUs. Information on expected level of vibration may be obtained from the Engineer. The installation shall comply with EN61373, EN50155, EN 50121-3-2),

12.6.5 The Contractor shall submit the following to the Engineer for review at least 3 months before the commencement of Cab Radio installation in the rolling stocks:

(1) Drawings showing equipment layout, racks, cabinets and enclosures. This shall include the mounting arrangement of the antenna on the rolling stocks. Racks & Cabinet layout drawings showing the arrangements of individual modules;

(2) Schematic diagrams and wiring diagrams of the System;
(3) Electric power requirements, wiring and earthing arrangements; and
(4) Inter cab cabling arrangements;

12.6.6 Installation Works in the cabs and inter cab wiring shall be carried out after the submissions have been reviewed without objection by the Engineer.

12.7 Cabling

12.7.1 All Outdoor Cables (Optical Fibre Cable inside HDPE Duct, Jelly Filled Telecom Quad Cable & PIJF Telephone Cables) shall be laid with in DFCC boundary and as far away from the track as possible. If it is necessary to lay cable outside the DFCC boundary, permission shall be obtained in advance from the concerned authority. It shall also be ensured that Jelly Filled Telecom Quad Cable and PIJF Telephone Cables shall not be laid between EDFC Track and Indian Railway Track.

12.7.2 The detailed guide lines for signalling cable laying have been laid down in Appendix 4 of PS for signalling, Volume 2, Part 2, Section VI of Employer's Requirements. These are applicable for Telecommunication cable laying also.

12.7.3 The Contractor shall prepare a Cable Route Plan in consultation with Civil/Track Contractor and get it approved from the Engineer before starting the trenching work. Instructions of Railway Board in this connection shall be followed.

12.7.4 All Ducts/Troughs/Trenches for outdoor cable laying, except at Concrete Bridges & Culverts, shall be provided by the Contractor.

12.7.5 Outdoor Cables in trench shall be laid as per Chapter XIII of Indian Railway Telecommunication Manual. Outdoor Cables shall be laid in a trench with depth of 1.2 metre from the natural earth profile or from the rail level whichever is lower and suitably protected with bricks. If it is inescapable in some sections to have both trenches(for Optical Fibre Cable route diversity) at same side of DFCC Track, one trench which is farthest from DFCC Track shall be of 1.7 meter depth from the natural earth profile.

12.7.6 Electrical Cables (Low Tension & High Tension) shall not be laid in same trench along with Outdoor Telecommunication Cables. Minimum separation between Electrical Cables and Outdoor Telecommunication Cables shall be maintained as specified in Indian Railway Telecommunication Manual.

12.7.7 Outdoor Signalling Cables and Outdoor Telecommunication Cables shall not be laid in same trench. If it is inescapable to lay Signalling Cables and Outdoor Telecommunication Cables in same trench, suitable separation shall be provided between the two as per the requirement of PS-Signalling Works, IRSEM and Indian Railway Telecommunication Manual and approved by the Engineer.

12.7.8 Outdoor Cables in rocky areas shall be laid as per Chapter XIII of Indian Railway Telecommunication Manual.

12.7.9 On Concrete Bridges &Culverts, duct on the both side of Railway Tracks will be provided by Civil Structure & Track Contractor for laying of cables. All Outdoor Telecommunication Cables (Optical Fibre Cable inside HDPE Duct, Jelly Filled Telecom Quad Cable & PIJF Telephone Cables) on these Concrete Bridges & Culverts shall be laid inside DWC Pipes. Entry/Exit of the Cables to/from Bridges & Culverts shall be suitably protected as approved by the Engineer. The Contractor shall carry out necessary co-ordination with Civil, Structure & Track Contractor in this matter.

12.7.10 Cable laid in the slope of track formation shall be laid Double Wall Corrugated Pipes. It shall be so laid to maintain a continuous depth of 1 meter (top of DWC Pipe) from the nearest ground level. The slope of track formation shall be restored to its original condition after laying of cables.

12.7.11 Following principles for laying of cables shall be adopted during Track/Road Crossings.

(1) The cable crosses the track/road at right angles.
(2) The cable does not cross the track under points and crossings.
(3) Boring or Trenchless technique shall be used while cable crosses the track/road.
(4) The cable is laid in HDPE Pipe of minimum 6 mm wall thickness/Double Wall Corrugated HDPE pipes while crossing the track/road.
(5) The cables are laid at a depth of 1.2 metre below the normal ground level or rail level, whichever is lower.
(6) Track formation/road surface shall be restored to its original condition after laying of cables.

12.7.12 Optical Fibre Cable shall be laid in Lubricated HDPE pipes.. Cables shall be laid in DWC pipe through trenchless method while crossing the road or the railway DWC pipe shall have a minimum 6 mm wall thickness.

12.7.13 Before commencing work on any part of the Site, the Contractor shall ascertain that the Engineer and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed each cable route without objection. The

Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served.

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

12.7.15 A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. Type of labels to be used shall be got approved by the Engineer.

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

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

(1) Remove such laid cable and cut into pieces of scrap of about 2 metres each;
(2) Lay new cable in lieu;

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

12.7.19 Cables in any trough/duct or tray/trunk/conduits shall not occupy cross-sectional space in excess of 50%.

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

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

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

12.7.23 All cables shall be adequately rated for their duties. All power cables shall be able to withstand full load current for peak operation when the equipment is at its ultimate capacity.

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

12.7.25 Underground Cable Route shall be identified by Electronic Cable Markers directly buried inside the trench with the approval of the Engineer.

12.7.26 The Contractor shall ensure that the maximum length of parallelism is suitable to the requirement of 25 KV AC AT Feeding Traction of DFCC and 25 KV AC Traction of nearby IR and shall meet the EMC/EMI requirements of individual equipment and system as a whole. The Contractor shall ensure that due to parallelism hazardous touch potential is not created.

12.7.27 The Outdoor Cables (Jelly Filled Telecom Quad Cable & PIJF Telephone Cables) in sufficient spare lengths (minimum 10 meters) shall be kept coiled in a circle of suitable diameter at 1.0 meter depth before being taken into TER /Location Boxes for termination. Such coils of cables in pits shall be adequately covered to provide protection against damage and theft.

12.7.28 All the cable entry into TER/Location Boxes etc. shall be suitably sealed to prevent entry of rodents etc.

12.7.29 Selection of cables and connectors shall be appropriate to their function. The Contractor must be able to demonstrate satisfactory usage of the type of cables proposed for use under tropical conditions, be able to comply fully with the specifications herein.

12.7.30 For Metallic Armour of the Optical Fibre Cable, Jelly Filled Telecom Quad Cable & PIJF Telephone Cables an earthing and gapping policy shall be incorporated into an overall earthing policy as reviewed by the Engineer.

12.7.31 A correctly coloured fibre splice protector shall be used to enclose each individual splice. Each fibre splice shall be tested to ensure correct fibre continuity and splice loss.

12.8 Identification

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

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

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

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

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

12.8.6 Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical or optical laser equipment.

12.9 Marshalling and Termination

12.9.1 General

12.9.1.1 Main distribution frames, digital distribution frames and optical distribution frames shall be provided at appropriate locations for signal termination, distribution, disconnection, diversion and in-circuit testing. Intermediate termination points shall also be provided as appropriate to allow cable network flexibility.

12.9.1.2 The signal termination and distribution practice shall adopt a consistent approach for easy circuit identification and is subject to the review of the Engineer.

12.9.1.3 The circuit terminations shall be secure enough to withstand vibration level, which is likely to be experienced in the railway environment. These terminations shall be designed to allow repeated circuit termination and disconnection.

12.9.1.4 Jelly Filled Telecom Quad Cable and PIJF Telephone Cables shall be terminated on Disconnection Type Terminal Blocks complying with IEC 60947-7-1. These Terminal Blocks shall be made of Polyamide 6.6 Insulating Material and shall use non-corrosive Metal Parts. These Terminal Blocks shall have provision for identification/number for each termination and shall be securely attached to Mounting Rails.

12.9.1.5 Wherever possible, standard multi-pin plug/socket shall be used to terminate multi-core cables for connecting to the equipment. Heat-shrinkable sleeves shall enclose all exposed and terminated contacts inside multi-pin connectors.

12.9.1.6 All RF Joints outside the cabinets shall be sealed by waterproof tapes or jackets.

12.9.2 Main Distribution Frame

12.9.2.1 Main distribution frame with 20% extra capacity for future expansion shall be provided at Telecommunication Equipment Room for the signal distribution of all voice, analogue, alarm and control circuits.

12.9.2.2 The Contractor shall provide at least five sets of the following accessories at each location where the main distribution frame is installed:

- tools for circuits connection and disconnection
- plug-in devices for circuit disconnection
- test cords and loop-back cords
- signal patch cords

12.9.2.3 The outgoing circuits connecting to external lines and all circuits affected by lightning or high induced voltage shall be provided with lightning arrestors and surge protection devices with the required earth connections. For details of Transient Protection refer to Para 12.12.

12.9.2.4 All voice, analogue, alarm and control circuits including spares shall be properly terminated at the main distribution frame.

12.9.2.5 The main distribution frame shall be divided into different zones for different types of circuits.

12.9.2.6 The main distribution frame shall be equipped with copper earth bar to which all cable shields shall be connected. The copper earth bar shall be connected to the earth.

12.9.2.7 The main distribution frame shall be equipped with facilities such as use of different colours or markers to aid circuit pairs identification.

12.9.2.8 The Contractor shall maintain records of all the circuit terminations.

12.9.3 Digital Distribution Frame

12.9.3.1 Digital distribution frame shall be provided at Telecommunication Equipment Room and at other locations as appropriate for data circuit termination.

12.9.3.2 The Contractor shall provide at least five sets of the following accessories at each location where the digital distribution frame is installed:

- plug-in devices for circuit disconnection
- test cords and loop-back cords
- signal patch cords.

12.9.3.3 Different modules in the digital distribution frame shall be provided for different types of data circuits.

12.9.3.4 The digital distribution frame shall be equipped with sufficient capacity for data circuits including spare circuits. The digital distribution frame shall also be equipped with an extra of 20% of termination capacity for future use.

12.9.3.5 Markers or labels shall be included in the digital distribution frame for easy identification of the circuits.

12.9.4 Optical Distribution Frame

12.9.4.1 Optical distribution frame shall be provided at Telecommunication Equipment Room, and at other locations as appropriate for optical signal distribution. Distribution frame shall comprise of equipment cabinet(s) or enclosures housing,

- fibre splice module
- fibre storage panel
- optical patch panel

12.9.4.2 All fibre cores terminating in the optical distribution frame shall be spliced to factory manufactured pigtails or properly stored in the fibre storage panel.

12.9.4.3 Optical patch cords shall be provided to connect the optical terminal to the optical distribution frame and for patching within and between optical patch panels.

12.9.4.4 Fibre storage panels shall be provided in the optical distribution frame to stow the excess length of pigtail and patch cords.

12.9.4.5 All splices shall be fusion splices and heat shrink splice sleeves shall be used for splice protection and housed in a fibre splice module.

12.9.4.6 All fibre splice modules shall be either telescopic or hinged type for easy access of splice elements.

12.9.4.7 All fibre splice modules shall be equipped with built-in fibre slack take-up mechanism.

12.9.4.8 All optical distribution panels shall be either telescopic or hinged type for easy access of rear side of panels. The optical distribution panel shall be fully equipped with adapters for optical signal termination.

12.9.4.9 All spare adapters shall be protected with jackets.

12.9.4.10 One high quality optical connector such as LC/FC/PC single mode (SM) 10/125µm type shall be standardised. Optical connector type specified on the transmission equipment shall be compatible with the optic fibre termination. The coupling loss of the connector shall be below 0.2dB.

12.9.4.11 All optical connectors shall comply with the ITU-T Recommendation G.652.

12.9.4.12 All pigtails and patch cords shall be properly labelled.

12.9.4.13 The optical distribution frame shall be equipped with sufficient capacity for all optical signal distribution and fibre storage. An extra of 20% capacity in each module shall be provided for future expansion.

12.9.4.14 All optical fibre splice configuration at each location shall be designed to fulfil the System fault tolerant requirement.

12.10 Power Supply Distribution

12.10.1 Electric Power Supply for Telecommunication Equipment is drawn from Main AC Distribution Boards as covered in Particular Specification for Signalling Works.

12.10.2 This 230 V AC Telecom Power Supply from Main AC Distribution Boards shall be taken to Telecommunication AC Distribution Board, from where it shall be distributed to all Telecom Equipment/Telecom Power Supply Equipment operating on 230 V AC. Telecom AC Distribution Board are equipped with MCBs of adequate capacity at Inputs and Outputs.

12.10.3 48 Volt DC Power Supply from 48 V DC Battery Backup System shall be taken to Telecom DC Distribution Board, from where it is distributed to all Telecommunication Equipment operating on 48 V DC. Telecom DC Distribution Board are equipped with MCBs of adequate capacity at Inputs and Outputs.

12.11 Earthing Policy

12.11.1 General

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

- to provide safety to the operating & maintenance personnel against the electric shock on account of any potential (voltage) appearing on exposed parts with respect to earth or due to electromagnetic or due to electrostatic induction;
- to ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the Telecommunication equipment;
- to protect the equipment against build-up of unduly high voltages, which can cause dielectric (Insulation) breakdown or damage to the equipment or their parts;
- to serve as common voltage reference point wherever required.

12.11.1.2 An earthing system shall be designed to assure personnel safety and protection of installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances.

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

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

12.11.1.5 Earthing and other protective measures in the following paragraphs are given only as indicative guidelines. The Contractor shall design, manufacture, install and be responsible for safe and correct working of all equipment/Subsystems under the scope of the Contract.

12.11.1.6 The Contractor shall submit, for review and approval the design for earthing, transient protection and lightning protection of all Telecommunication Subsystems including earthing and lightning protection of the radio tower and trains. OEM's original data sheets of the proposed devices shall also be submitted.

12.11.2 Requirements of effective Earthing

12.11.2.1 The Earthing system shall meet or exceed the requirements of IEEE 1100, NFPA 780, IEC 1024 and ITU-T Recommendation K.27 or relevant International standards.

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

- protect personnel and equipment from electrical hazards, including lightning and reduce fire hazards;
- reduce potential to system neutrals;
- enable signalling with earth return;
- reduce or eliminate the effects of electrostatic and electromagnetic interference arising from within the EDFC on account of traction voltages, traction return current, electric locomotive characteristics and other extraneous sources;
- minimise service interruptions and equipment damage:
- minimise radiated and conducted electromagnetic emissions:
- reduce radiated and conducted electromagnetic susceptibility:
- improve system tolerance to discharge of electrostatic energy and lightning interference:
- provide a proper earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies; and
- provide a clean zero-volt reference point where required.

12.11.2.3 The earthing system shall be so designed as to give earth resistance within the stipulated limits at all locations and under all climatic conditions.

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

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

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

12.11.3 Earthing of Indoor Equipment

12.11.3.1 Main earth bus bar shall be provided in the power supply room by the Contractor. The Contractor shall provide minimum 16 mm² cable from the power supply room to the TER and terminate on copper earthing strips of sufficient size and specifications. These earthing strips shall be used by the Signalling Contractor to extend individual earths to cables and racks/equipment etc.

12.11.3.2 In order to ensure a captive earth connection to the cabinets and racks in TER, a minimum cross-section of 16 mm² copper wire shall be used for earthing.

12.11.3.3 The cabinets within a row are to be conductively connected by means of screws and contact washers. Two or more rows are interconnected via the earth bus and if necessary, also by additional earthing cables. In case that one of the cabinets/racks is removed, it shall be ensured that the other cabinets in the row remain earthed

12.11.3.4 Earthing strips will be connected to a Common Bonding Network (CBN)

12.11.4 Earthing of Outdoor Installations

12.11.4.1 Outdoor installation, listed below, shall be earthed to the nearest Main earth bus bar with a minimum 16 mm² copper conductor:

- metallic sheath and armouring of all cables at regular intervals;
- location boxes;
- racks;
- clocks display units; and
- any other Telecommunication installation as may be necessary to cover complete scope of works defined in the Contract.

12.11.4.2 The Contractor shall also use suitable safety methods such as screen of wire mesh (earthed) for safety of maintenance staff wherever there is infringement of equipment installation in the signal clearance zone as per Indian Railway's Railway Electrification practices.

12.11.5 Earthing Arrangement

12.11.5.1 The Contractor shall provide two separate earth connections, a clean earth connection to the earth terminals provided inside the rooms where the Telecommunication equipment is installed, and a main earth connection for the earthing of radio towers, antenna feeder cables, equipment chassis, etc. of the Telecommunication System.

12.11.5.2 The earthing system shall meet, but not be limited to, the following:

- The resistance to earth of the system "earth terminal" shall remain within the stipulated limits at all locations and under all climatic conditions.
- Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.

12.11.5.3 The earthing arrangements for Antenna Towers and Antennae shall be such that:

- The zone of coverage shall afford protection of all objects forming part of the Antenna Towers and Antennae including any objects near the base of the tower, and this factor shall be taken into consideration while deciding the height of the lightning conductor at the top of the tower.
- Earthing of VHF/UHF Antenna Feeder Cables having Copper Sheaths shall be such as to maintain a low resistance connection to the earth. Any junction forming a part of this connection shall be protected from ingress of moisture by using proper wrapping, sealing with water-proof tapes, or suchother measures. The connection shall be inspected periodically at intervals frequent enough to ensure that the earth connection meets all the requirements. Earthing kits of approved type shall be used for this purpose.

12.11.5.4 The earthing arrangements for Telecommunication Equipment shall be as below:

- All Telecommunication equipment shall be protected using a mesh of copper "earth" strips of appropriate cross-sectional dimensions, forming a local clean earth bus.
- Each equipment rack shall be connected electrically to this bus. This bus shall be connected to the external ring earth forming a Common Bonding Network (CBN) at the shortest possible distance from two opposite points of this bus.
- All joints of this connection shall be protected from ingress of moisture by using proper wrapping, sealing with water-proof tapes, or such other measures.
- The earthing connection shall be inspected periodically at intervals frequent enough to ensure that the earth connection meets all the requirements.

12.11.5.5 The metallic sheath and armouring of all cables (RF Cables/Optical Fibre Cable/Others) shall require earthing. In the section earthing shall be done as per the established practices in RE areas of the Indian Railways.

12.11.5.6 The earthing electrodes for the clean earth shall be located at least 20 m away from the main earth.

12.11.5.7 The route for the clean earth shall be so chosen as to minimise the effect of any inductive interference.

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

12.11.5.9 The earth resistance at any point on the clean earth shall be below 0.5 Ohm, and that for the main earth shall not exceed 1.0 Ohm at any location and under any soil and/or climatic condition.

12.11.5.10 All metal work and metallic items shall be earthed to the main earth to ensure the safety of personnel.

12.11.5.11 The earthing methods and details shall be submitted to the Engineer for review.

12.11.5.12 Radio equipment shall be provided with isolated terminations for the connection of coaxial cables extending to equipment in external locations.

12.12 Transient and Lightning Protection

12.12.1 It is recognized that lightning and faults on nearby electrical installations as sources of dangerous disturbances in telecommunications lines, which may cause damage leading to interruptions in service and the need for repairs or even hazards to personnel.

12.12.2 It is therefore essential to set out principles which enable the frequency and seriousness of such disturbances to be limited to levels which take account of quality of service, operating costs and safety of personnel. The disturbing phenomena, when they appear, are relatively rare or of very brief duration (usually of the order of a fraction of a second) and hence consideration must be given to methods of avoiding interruption of the functioning of equipment during an actual disturbance. (ITU-T Recommendation K.11, 06 October, 1993 and ITU-T Recommendation K.36, 08 May, 1996)

12.12.3 General considerations

12.12.3.1 Origin of dangerous over voltages and over currents.

(1) Direct lightning strikes may cause currents of some thousands of amperes to flow along wires or cables for some microseconds. Physical damage may occur and overvoltage surges of many kilovolts may apply stress to the dielectrics of line plant and terminal equipment.

(2) Lightning strikes nearby - lightning currents flowing from cloud to earth or cloud to cloud cause over voltages in overhead or underground lines near to the strike. The area affected may be large in areas of high earth resistivity.

(3) Induction from fault currents in power lines including electric traction systems. Earth faults in power systems cause large unbalanced currents to flow along the power line inducing over voltages into adjacent telecommunications lines which follow a parallel course. The over voltages may rise to several kilovolts and have durations of 200 to 1000 ms (occasionally even longer) according to the fault clearing system used on the power line.

(4) Contacts may occur between power and telecommunication lines when local disasters, e.g. storms, fires, cause damage to both types of plant or when the normal safeguards of separation and insulation are not followed. Resulting overvoltage may cause excessive currents to flow along the line to the exchange earth causing damage to equipment and danger to staff.

(5) Earth faults in power systems cause currents in the soil which raise the potential in the neighbourhood of fault and of power supply earth electrode. Raised earth potentials affect telecommunication plant in two ways:

(a) Telecommunication and Signalling Systems may malfunction if the signalling earth electrode is in soil whose potential rises by as little as 5V with respect to true earth.

(b) Higher rises of earth potential can cause danger to staff working in the affected area or, in extreme cases, may be sufficient to break down the insulation of the telecommunications cable causing extensive damage.

12.12.3.2 Protective measures by the Contractor external to the conductors themselves.

(1) Telecommunication lines should be shielded from lightning to some extent by adjacent earthed metal structures, e.g. power lines or electric railway systems. Efficient metallic screens either in the form of cable sheaths, cable ducts or lightning guard wires, reduce the effects of lightning surges or power line induction. In areas with a high risk of lightning strikes special cables with multiple screens and high strength insulation should be used including bonding all metal work for useful protection.

(2) Induction from power lines may be minimized by coordinating the construction practices for the power and telecommunication lines. The level of induction may be reduced at its source by the installation of earth wires and current limiters in the power system.

(3) The likelihood of contacts occurring between power and telecommunications lines is reduced if agreed standards of construction, separation and insulation are followed. Economic considerations arise but it is often possible to benefit from jointly using trenches, poles and ducts, providing suitable safe practices are adopted. It is particularly important to avoid contacts with high voltage power lines by a high standard of construction since, if such contacts occur, it may be very difficult to avoid serious consequences.

12.12.3.3 The Contractor shall use special cables as follows:

(1) Cables of high dielectric strength where high over voltages are likely to occur.
(2) Cables with strengthened insulation in situations where there is exceptional proximity or length of parallelism to power lines, high rise of earth potential in the immediate neighbourhood of power stations or extreme exposure to lightning due to high keraunic level and low soil conductivity.
(3) Cables with metal sheaths which provide a good reduction factor to screen circuits within the cable.
(4) Cables which carry circuits to exposed radio towers and which must be able to carry lightning discharge currents without damage.

(5) All di-electric (i.e. non-metallic) optical fibre cables to effect isolation between conductive lengths of cable.

12.12.3.4 It is also essential that the Contractor uses protective devices under circumstances, as follows:

(1) Where cables with extra thick insulation may themselves be undamaged by over voltages or over currents but they can nevertheless conduct such conditions to other more vulnerable parts of the network. Extra protection is then required for the more vulnerable cables and is particularly important if these are large underground cables which are expensive to repair and affect service to many customers.

(2) Where induced over voltages from power or traction line faults may still exceed levels permitted by the Directives even after all practicable avoidance measures have been followed.

(3) Protective devices to include air gap protectors with carbon or metallic electrodes, Gas discharge Tubes, semi-conductor protective devices, fuses, heat cols, self-restoring current limiting devices, fusible links, MOVR.

(4) Suitable electronic devices (such as silicon avalanche suppressor devices/transzorbs) having high surge handling capability, fast response time and low clamping voltage, etc.; shall be incorporated in the Telecommunication equipment to ensure that the latter withstands the above mentioned conditions without any damage or permanent degradation in performance throughout the system lifetime. The selection criteria for such devices shall include, but not be limited to, the following:

(a) reverse standoff voltage shall be at least twice the maximum operating voltage;
(b) pulse power rating shall be adequate to handle the peak pulse power of the transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from overhead traction power system;
(c) device lifetime shall not be less than that of the system for which it affords protection.

12.12.3.5 Surge protection devices shall be provided at TER end and outdoor equipment end, on power and data cables extending to outdoor telecommunication equipment installations as a minimum as defined below:

(1) clock displays surge protection devices at both ends

(2) radio frequency feeder cables separately for each individual cable of VHF antenna & GPS antenna on both ends;

(3) armour of optical fibre cable shall be directly earthed at TER end and earthed through a surge protection device at the other end station;

12.12.4 Transient Lightening Protection Specifications

12.12.4.1 An effective transient protection system, complying to the following as a minimum must be provided to protect the telecommunication equipment from transients:

12.12.4.2 Peak transients of up to 700 Volts on the DC Power Supply line for several microseconds.

12.12.4.3 Average transient duration of 2 microseconds with a repetition frequency of 15 KHz to 100kHz.

12.12.4.4 For short duration transients (<5ms) the variation approaches a sine wave.

12.12.4.5 For longer duration transients (>5ms) the variation approaches rectangular pulses with an initial rate of rise up to 5x104 Volts per second

12.12.5 Housing, Enclosure and Cabinet

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

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

12.12.5.3 Unless specified otherwise, all equipment to be housed in outdoor environment (open areas, etc.) shall be with IP 65 enclosures as a minimum.

G **End of Chapter 12** G

CHAPTER 13 - TESTING AND COMMISSIONING

13.1 General

13.1.1 The Contractor shall perform stage-wise testing and commissioning activities in accordance with the requirements given in this Specification.

13.1.2 The Contractor shall ensure that prior to the commencement of tests; documentation associated with tests has been reviewed without objection by the Engineer.

13.1.3 The Contractor shall ensure that the equipment/Subsystem/System is in a state ready for testing and commissioning before the commencement of the tests. The Contractor shall conduct trial tests and satisfy himself before offering the equipment/Subsystem/System for the tests. Test results of the Contractor's own trial tests shall be made available to the Engineer on request. This is to indicate the readiness of the equipment/Subsystem/System for tests.

13.1.4 The Contractor shall provide all necessary test instruments, special tools, emulators, simulators and test software to carry out the tests.

13.1.5 The Contractor shall satisfy himself that all items interfacing to Project Contractors are in satisfactory condition for the Contractor's tests to be carried out. The Contractor shall provide simulation for testing in case the interfacing equipment is not available for testing.

13.1.6 The Contractor shall extend full support to the Engineer and provide all necessary facilities to enable convenient inspection of materials, work and testing.

13.1.7 The Contractor shall investigate and provide corrective actions for all the faults detected during the tests. The tests shall be resumed only after all the faults are properly cleared. The Contractor shall submit fault report to the Engineer to describe the symptom and causes of the faults and the corrective actions taken.

13.1.8 If the operation of other Project Contractor's system or equipment is suspected to be affected by the system during the test, the Contractor shall withhold the test, investigate and take corrective actions, if necessary, before resumption. The test shall be resumed only after the interference has been eliminated or found not to be related to the System.

13.2 Testing Stages

13.2.1 The Contractor shall carry out testing and commissioning activities in the following phases:

(1) Factory Acceptance Tests;
(2) Installation Tests;
(3) System Acceptance Tests; and
(4) Integrated Testing and Commissioning.
(5) Service Trial.

13.3 Factory Acceptance Tests

13.3.1 The Contractor shall prepare and submit, at least six months before the tests, for review by the Engineer the Factory Acceptance Test Plan, detailing and explaining how the contractor shall plan, perform, and document all inspections and tests that shall be conducted to verify and validate the works prior to delivery to Site. In addition, the Factory Test Plan shall also include the following:

(1) a list of equipment and cables for individual Subsystems to have Factory Acceptance Test;
(2) the program of all the activities related to factory acceptance tests;
(3) the locations where factory acceptance tests to be carried out;
(4) the estimated duration of tests activities at each location; and

(5) submission schedule of all the factory acceptance test procedures for equipment and cable.

13.3.2 Factory Acceptance Test shall be carried out for equipment and cables of all the Subsystems.

13.3.3 The Contractor shall carry out factory acceptance tests at the place of manufacturing. The test shall include, but not be limited to, visual inspection, environmental tests, electrical tests, functional tests and fatigue tests on each individual equipment and associated Subsystem as well as cables before delivery of the equipment to the Site.

13.3.4 The environmental tests and fatigue tests are not required; if it has already been conducted and independently witnessed previously on similar item and test results are accepted by the Engineer.

13.3.5 The Contractor shall prepare the factory acceptance test procedures for equipment and cables and submit to the Engineer for review. The factory acceptance test procedures shall describe in detail all tests to be performed on the equipment and cables along with pass/fail criteria (i.e. the standards or limit to be achieved).

The Factory Acceptance Test shall not be started unless the factory acceptance test procedures have been reviewed without objection by the Engineer.

13.3.6 Factory Acceptance Tests shall be witnessed by the Engineer, however on all major equipment items or Subsystems identified during Detailed Design Stage factory acceptance tests shall be witnessed jointly by the Employer's Personnel and the Engineer.

13.3.7 Where any part of testing is carried out by an independent laboratory, a copy of Test Certificate issued by the relevant authority of that laboratory shall be submitted along with the Factory Acceptance Test Procedure.

13.3.8 The Factory Acceptance Tests are considered completed only if the Engineer without objection reviews the Factory Acceptance Test results.

13.4 Installation Tests

13.4.1 Installation Tests shall be carried out on individual Subsystem location by location after the completion of equipment physical installation.

13.4.2 The objective of the installation tests shall be to ensure the following:

(1) the equipment is installed in accordance with the reviewed design documentation
(2) the equipment is installed in accordance with the requirements detailed in this Specification
(3) all cables are properly and accurately connected and terminated
(4) all installation works are of acceptable workmanship

13.4.3 The Contractor shall develop procedures for Installation Tests and submit to the Engineer for review. The installation test procedures shall describe in detail all tests to be performed on the equipment and cables along with pass/fail criteria (i.e. the standards or limit to be achieved).

(1) The Installation Test shall not be started unless the installation test procedures have been reviewed without objection by the Engineer.

(2) All installed equipment and cables shall be physically inspected against all relevant reviewed design documentation.

(3) The Contractor shall measure the end-to-end performance of all cores of the copper cables and optical fibre cables, including all spare cores, laid between different locations.

(4) The Contractor shall verify all the connections within the antenna network and measure the attenuation and VSWR values of all the connections.

(5) All the installation test results, physical locations of the equipment and serial numbers shall be captured in the test record forms. The Contractor shall include completed test record forms in the Test Report and submit to the Engineer for review.

(6) The Installation Tests are considered completed only if the Engineer without objection reviews the Installation Test results.

13.5 System Acceptance Tests

13.5.1 The Contractor shall carry out System Acceptance Tests after the completion of the Installation Test.

13.5.2 System Acceptance Tests shall be carried out on individual Subsystem as well as whole System to verify the functional, operational performance, electrical performance and services coverage at the stage:

(1) after successful completion of the Installation Tests;

(2) after the Subsystems have been configured with correct settings and parameters;

(3) properly connected to the power supply and can be switched on for System Acceptance Tests; and

(4) before the equipment of different locations are ready for Integrated Testing & Commissioning.

13.5.3 The Contractor shall develop System Acceptance Tests procedures for each Subsystem and System as a whole and submit to the Engineer for review.

13.5.4 The System Acceptance Tests procedures shall include:

(1) objectives of the System Acceptance Tests for all subsystems;

(2) objectives of the System Acceptance Tests for system as a whole;

(3) list of specifications and standards, reviewed design documentation for reference;

(4) step-by-step test instructions;

(5) list of test instrument and special tools;

(6) test record forms; and

(7) pass or fail criteria.

13.5.5 Where performance across interfaces to other System within this Contract is required to be verified during the System Acceptance Tests, the Contractor shall include a list of other systems and the interface test procedures in the System Acceptance Tests procedures for the relevant Subsystem.

13.5.6 Where performance across interfaces to Project Contractors or to other parties is required to be verified during the System Acceptance Tests, the Contractor shall include a list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the System Acceptance Tests procedures for the relevant Subsystem.

13.5.7 The functional, electrical and timing performances of the Subsystems as well as System as a whole shall be verified against the requirements and relevant international standards.

13.5.8 The Contractor shall conduct end-to-end circuit test to verify the circuit integrity and electrical performance for all circuits including spare.

13.5.9 All local alarms, control and monitoring functions shall be verified.

13.5.10 All equipment settings and parameters shall be verified and recorded in the reviewed test record forms.

13.5.11 Coverage test shall be carried out on location basis for the Radio system.

13.5.12 All protection mechanisms such as hot-standby, parallel redundancy, automatic switchover, etc., built into the system and individual Subsystems shall be verified.

13.5.13 The system response time of relevant Subsystems and the System shall be tested and measured.

13.5.14 The Contractor shall carry out load test on each Subsystem to verify the designed system capacity and performance in accordance with the requirements given in the Particular Specification under full load condition.

13.5.15 The Contractor shall carry out tests on the operation of the System in accordance with the normal operation procedures and emergency operation procedures, which has been reviewed without objection by the Engineer.

13.5.16 The System Acceptance Tests are considered completed only if the Engineer without objection reviews the System Acceptance Test results.

13.5.17 Upon completion of the System Acceptance Test, the individual Subsystem shall be operational and ready to be connected to other Subsystems and interfacing systems for testing.

13.6 Integrated Testing and Commissioning

13.6.1 The Contractor shall carry out Integrated Testing and Commissioning after the completion of the System Acceptance Tests.

13.6.2 The Contractor shall co-ordinate with the Engineer and with all the interfacing Project Contractors/Parties to ensure all the interface test activities are completed in accordance with the program on Completion Plan.

13.6.3 The Contractor shall provide all necessary supports, conduct investigation and provide corrective actions, if necessary, to ensure all matters related to interfacing are properly resolved.

13.6.4 Within one week upon completion of all interface test activities, the Contractor shall submit the test results to the Engineer for review.

13.6.5 After the test results of all interface test activities have been reviewed by the Engineer without objection, the Contractor shall start the Reliability Demonstration Test in accordance with the reviewed Reliability Demonstration Test Plan.

13.6.6 The Contractor shall advise the Engineer in writing the commencement date of the Reliability Demonstration Test.

13.6.7 The Contractor shall submit a Reliability Demonstration Test Plan to the Engineer for review at least three months before the test.

13.6.8 The Contractor shall include the following in the Reliability Demonstration Test Plan as a minimum:

(1) calculation of the maximum allowable number of failures of equipment, Subsystems and System during the reliability demonstration period in accordance with requirements on reliability performance of the equipment, Subsystems and System given in the Particular Specification

(2) definition of relevant failures

(3) pass and fail criteria

(4) sample of fault logs

13.6.9 During the reliability demonstration test period, the Contractor shall record details of all faults in a fault log which shall include:

(1) the date and time the fault occurs

(2) the date and time the Contractor’s staff arrive on site

(3) the date and time the fault is cleared and the normal operation is restored

(4) the description of the fault

(5) the cause of the fault

(6) equipment or component replaced

13.6.10 All fault logs shall be submitted to the Engineer for review.

13.6.11 The reliability demonstration test is considered a failure if:

(1) the actual number of relevant failures exceeds the maximum allowable number of failures for any equipment, Subsystems or System identified in the Reliability Demonstration Test Plan

(2) any fault resulting from the Design omission or commission of error requires Design modification in order to fix the fault

13.6.12 If the reliability demonstration test fails, the Contractor shall provide all the necessary corrective actions and rectify the fault to the satisfaction of the Engineer.

13.6.13 The reliability demonstration test shall be repeated on the affected Subsystem or Subsystems for another three months until the test is successfully completed.

13.6.14 Within two weeks upon completion of the reliability demonstration test, the Contractor shall submit the test results for the Engineer to review.

13.6.15 The Integrated Testing and Commissioning is considered completed only if all the test results of the Integrated Testing and Commissioning have been reviewed by the Engineer without objection.

13.7 Service Trials

13.7.1 The Contractor shall provide all necessary support and attendance to the Engineer during the Service Trials period.

13.7.2 The Contractor shall provide on-Site supports to the Engineer in all aspects related to the operation of the System. The Contractor shall also conduct investigation and provide corrective actions for any problems related to the System or the interfaces with the System.

13.7.3 The Contractor shall assign competent staff to support the Service Trials as required by the Engineer. The persons shall be the technical staff who shall have sufficient skills and knowledge of the System and shall have been involved in the Design, installation or commissioning of the System.

13.7.4 The Contractor shall submit a Manpower Plan to the Engineer for review at least 1 month before the commencement of the Service Trials.

13.7.5 The manpower plan shall include the organisation chart of the Contractor's Service Trials supporting group, individual person's role and responsibility and 24-hour contacts for emergency cases.

G End of Chapter 13 G

CHAPTER 14 - SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

14.1 Spares

14.1.1 General

The Contractor shall provide his own spares during Installation & Commissioning Period as well as during the Defects Notification Period. The Contractor shall also provide separate spares for the Employer to enable the Employer to operate and maintain the System.

14.1.2 Contractor's Own Spares

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

(1) the expected failure rate of the parts;

(2) population of the parts in the System;

(3) criticality of the parts in the System;

(4) availability figures of the System;

(5) spare delivery lead time; and

(6) workshop repair turnaround time.

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

14.1.2.3 The Contractor shall submit the list of Defects Liability Spares, with the types and quantities of spares, the Contractor intends to hold, at least six months before the commencement of the Defects Notification Period to the Engineer for review.

14.1.2.4 The Contractor shall include details of the stock of the Contractor's own spares in the Monthly Progress Report. The status of the spares, either in store or under workshop repair, shall also be included.

14.1.3 Contract Spares for Employer's Operational and Maintenance Requirements

14.1.3.1 The Contract Spares, to be supplied by Contractor to Employer for Employer's Operational and Maintenance Requirements, shall include spare modules, sub-assemblies, special components, cables, connectors, fuses etc. The Contract Spares to be supplied shall be as per the following list.

SN	Item	Total Quantity
1	SDH Node complete with all tributary cards and full hardware redundancy	1 of each type
2	2 Mb Mux complete with all channel cards and full hardware redundancy	2 of each type
3	All type of PCB cards including mother board ,Optical line termination Card,E1 Tributary card and power supply card for STM- Mux	10% of the total population for each type

SN	Item	Total Quantity
4	All type of PCB cards including mother board, 2MB card ,VF card, E&M Card ,Data card and power supply card for 2 MB Mux	10% of the total population for each type
5	Notebook computer loaded with OFC NMS software	2
6	Layer-3 Switch	10% of the total population for each type
7	Layer-2 Switch	10% of the total population for each type
8	Direct Line Console Complete for OCC	1
9	Direct Line Console Complete for SCR	1
10	PBX Subscriber Line Cards	10% of the total population for each type
11	PBX Junction Line Cards	10% of the total population for each type
12	PBX Switch Cards	10% of the total population for each type
13	PBX System Control Cards and Power Supply Card	10% of the total population for each type
14	Digital Telephone Instruments	10% of the total population for each type
15	Analogue Telephone Instruments	10% of the total population for each type
16	Media Gateway	10% of the total population for each type
17	Direct Line Telephone Instruments other than Direct Line Console	10% of the total population for each type
18	All type of replaceable/plug-in modules for Voice Recording System	10% of the total population for each type
19	Control Office Equipment of Control Communication Equipment	1 of each type.
20	Way-Station Equipment of Control Communication Equipment	10% of the total population for each type
21	Notebook Computer loaded with PBX NMS Software	1
22	Base Transceiver Station(BTS)	1
23	All type of Replaceable/Plug-In Modules for BTS	10% of the total population for each type
24	All type of Replaceable/Plug-In Cards/Modules for BSC and TRAU	10% of the total population for each type
25	All type of Replaceable/Plug-In Cards/Modules for OMC	1 Card of each type.
26	Radio Dispatcher Console with associated hardware/accessories	1

SN	Item	Total Quantity
27	Antennae for BTS	6
28	Cab Radio with Associated Hardware/Accessories	5
29	Replaceable/Plug-In Cards for Master Clock	1 Card of each type
30	Station Sub-Master Clock Complete	10% of the total population for each type
31	Digital Clock Units	10% of the total population for each type
32	Analogue Clocks	10% of the total population for each type
33	25 Watt VHF Transceivers along with Antennae, Associated Voice Recording Equipment and other associated Hardware/Accessories.	2
34	SMPS Based Float Cum Boost Charger (48 V DC)	4
35	All type of Replaceable/Plug-In Cards/Modules for SMPS Based Float Cum Boost Charger	10% of the total population for each type
36	Maintenance Free Batteries	10% of the total population for each type
37	Fuses of all types	10% of the total population for each type
38	Terminals of all types	10% of the total population for each type
39	Transient/Surge Protection Device	10% of the total population for each type
40	Optical Distribution Frame	10% of the total population for each type
41	Telephone Cable Termination frame	10% of the total population for each type
42	Copper Cable Jointing Kits for all sizes of cables	10% of the total population for each type
43	Splicing Kits for OFC	10% of the total population for each type
44	Optical Fibre Cable	10 km for each type
45	Optical Fibre Splice Box & remake loops	10% of the total population for each type.
46	Optical Pigtail Cables	10% of the total population for each type.
47	Outdoor Telephone Cable	10% of the total population (km) for each type.
48	Indoor Telephone Cable	10% of the total population (km) for each type.
49	6 QUAD CABLE	10% of the total population (km) for each type.

SN	Item	Total Quantity
50	All type of Connectors/Dummy Loads	10% of the total population for each type.
51	Emergency Socket	10% of the total population for each type.
52	Portable Emergency Telephone Set	10 Nos.

NOTE: The Quantity shall be rounded to nearest decimal natural number with minimum 1(one).

14.1.3.2 The Contractor shall submit list the of Contract Spares along with quantities at least 6 months before start of 'Defects Notification Period', based on approved tentative BOQ which shall be adjusted on approval of As-Built BOQ.

14.1.3.3 The list of Contract Spares shall include information such as brand name, model number, serial number (if applicable), rating(if applicable), description, part number(if applicable), drawing number, shelf life, bar-coded (as directed by the Employer) etc. of each item of Contract Spares.

14.1.3.4 The Contractor shall indicate the sources of supply of each item of Contract Spares and shall guarantee their availability during the service life of the system.

14.1.3.5 All Contract Spares shall be tested as per reviewed factory acceptance testing procedures before delivery to the Employer. The delivery to the Employer shall be completed by the start of 'Defects Notification Period'.

14.1.3.6 Any item not included as Contract Spare and subsequently found to be necessary during Defects Notification Period, shall be supplied by the Contractor in required quantities as variation to Contract under direction of Engineer.

14.2 Special Tools and Test Equipment

14.2.1 The Contractor shall provide his own test equipment and tools during the Installation & Commissioning Periods and Defects Notification Period.

14.2.2 The following Special Tools & Test Equipment shall be suitably packed and supplied to the Employer.

SN	Item	Total Quantity	SN
1	E1 Analyser	Nos.	4
2	Auto fusion splicing machine complete.	Nos.	4
3	SDH Analyser	Nos.	2
4	OTDR mini	Nos.	4
5	OTDR main frames	Nos.	2
6	Optical fibre tool box Impairment (TIMS)	Nos.	4
7	Transmission measuring set	Nos.	2
8	Digital multi-meter	Nos.	12
9	Earth tester	Nos.	2
10	Megger 500 Volts	Nos.	2
11	Mega OHM meter	Nos.	1

SN	Item	Total Quantity	SN
12	Optical Power Source	Nos.	4
13	Optical Power Meter	Nos.	4
14	Optical Variable Attenuator	Nos.	2
15	PCM channel analyzer with printer	Nos.	1
16	Cable tool kit	Nos.	6
17	Base Station Analyser	Nos.	2
18	RF Analyser	Nos.	2
19	Cable Route Locator	Nos.	2
20	Portable Generator 1.5 KVA	Nos.	2
21	Emergency light	Nos.	4
22	Ethernet Analyser	Nos.	2
23	Cable & Antenna Analyser	Nos.	4
24	RF Power Sensors	Nos.	4
25	Vehicle Mountable Drive Test Equipment for GSM-R	-	1 (System)
26	General purpose telecom tool kit.	Nos.	12
27.	Power supply (Variable) 0 to 60 Volt DC	Nos.	6
28	Vacuum Cleaner	Nos.	4
29.	Maintenance Vehicle (Semi Utility Vehicle Type)	Nos.	2
30	Drilling machine with hammer action capable of working on wood, metal, concrete complete with chuck drill bits	Nos.	6
31	VHF Power Meter with all accessories	Nos.	1
32	Fibre Microscope	Nos.	4

14.2.3 The Contractor shall submit the technical specifications, datasheets and operational manual of each type of Special Tool & Test Equipment at least six months before the start of Defects Notification Period to the Engineer for review.

14.2.4 All Special Tools & Test Equipment shall be supplied together with all cords and connectors, operation manuals, complete diagrams, schematics, assembly and connection drawings, maintenance instructions and calibration certificates.

14.2.5 None of the Special Tools & Test Equipment provided for the Employer shall be used on site prior to delivery to the Employer.

14.2.6 The supply of Special Tool & Test Equipment shall be completed by the start of Defect Notification Period.

14.2.7 All tools and test equipment required in the field for restoration of the network shall be suitably fixed in the maintenance vehicle (Mobile Telecommunication maintenance

vehicle), so that in case of failures, the mobilisation time is minimised and complete equipment required for repair are carried by the maintenance vehicle.

***End of Chapter 14** G

APPENDIX – I

Fax : 91-0522-2458500
Telephone: 91-0522-2451200(PBX)
91-0522-2450115 (DID)

Government of India Ministry of Railways
Research Designs & Standards Organisation
LUCKNOW-226011

No. STT/WL/MTRC/503 Dated: 16.09.2005

To,

The CSTE & CSTE / Construction,

1. Eastern Railway, Fairly Place, Kolkata – 700001
2. Northern Railway, Baroda House, New Delhi – 110001
3. Northeast Frontier Railway, Maligaon, Gowahati – 781011
4. North Central Railway, Allahabad

Sub: Uniform Numbering Scheme for Mobile Train Radio Communication Network for Indian Railways.

Uniform Numbering Scheme for Mobile Train Radio Communication has been prepared by RDSO for implementation on Zonal Railways. It is proposed to have network name as IR-GSM-R (maximum 8 Character), which will be displayed on mobile instruments. Railway Access Code (RAC) of Indian Railway MTRC network will be 091.

Presentation on numbering scheme was made on 15.09.2005 in the Railway Board during review of progress of MTRC sanctioned works. A copy of Uniform Numbering Schema for Mobile Train Radio Communication is sent herewith for comments.

It is requested that the comments on the numbering scheme may be sent to RDSO/ Lucknow within SEVEN days for finalizing the Numbering Scheme. If no reply is received within SEVEN days, it will be presumed that there is no comment from Railway Uniform Numbering Scheme is required by Eastern Railway and N.F. Railway for planning and programming of SIM cards and other functional requirements.

(A.K. Mishra)
Director/Stds../Tele-II
For Director General/Telecom

DA: As above.

NUMBERING SCHEME FOR MOBILE TRAIN RADIO COMMUNICATION NETWORK OF INDIAN RAILWAYS

1. International Mobile Subscriber Identity (IMSI)

Railway	MCC	MNC	MSIN	
			HLR Identification Code	
Zone	405	48	8 digit as listed below	00000000-99999999

For Eastern Railway, IMSI numbers will be

Railway	MCC	MNC	MSIN	
			HLR Identification Code	
Eastern Railway	405	48	250	00000000-99999999

1. Numbers from 0000000 to 9999999 can be used depending on numbers of SIM cards. Eastern Railway will be using only 410 SIM cards. Initially; the numbers to be used will be from 0000000-0000410. The balance may be kept as reverse to cater for future procurement.

2. If each Railway (18 nos.) will be having separate MSC and HLR, then they will be having separate HLR identification code i.e. 250 for Eastern Railway, 100 for Central Railway and so on as per table given below. If any two or more zones use same HLR, then they will be having same HLR identification code.

Railway	HLR Identification Code
Central Railway	100
East Central Railway	150
East Coast Railway	200
Eastern Railway	250
North Central Railway	300
North Eastern Railway	350
North Western Railway	400
North East Frontier Railway	450
Northern Railway	500
South Central Railway	550
South East Central Railway	600
South Eastern Railway	650
South Western Railway	700
Southern Railway	750
West Central Railway	800
Western Railway	850

2. Mobile Subscriber ISDN Number (Call Type 8) for Eastern Railway:

Railway	CC	NDC		CT 8	Subscriber Number			
		AC	ZONE		HQ/Divn.	Deptt.		
Eastern Railway HQ	91	99	25	8	0	0	GM	0000-0199
							Vigilance	0200-0299
							CPRO	0300-0399
							Law	0400-0499
							Civil Defence	0500-0599
							Audit	0600-0699
							Reserved	0700-0999
							MSRN, HON, GCN	1000-1999
							Reserved	2000-9999
	91	99	25	8	0	1	Personnel and Commercial	0000-9999
							Officers (Personnel)	0000-0099
							Supervisors (Personnel)	0100-0299
							Reserved	0300-0999
							Officers (Commercial)	1000-1099
							Supervisors (Commercial)	1100-1299
							Reserved	1300-1999
							Reserved	2000-9999
	91	99	25	8	0	2	Security and Medical	0000-9999
							Officers (Security)	0000-0099
							Supervisors (Security)	0100-0299
							Reserved	0300-0999
							Officers (Medical)	1000-1099
							Supervisors (Medical)	1100-1299
							Reserved	1300-1999
							Reserved	2000-9999
	91	99	25	8	0	3	Electrical	0000-9999
							General	0000-0299
							Officer	0000-0049
							(Maint.+Con.)	
							Supervisor	0050-0199
							(Maint.+Con.)	
							Reserved	0200-0299

Eastern Railway HQ						TRD	0300-0599
						Officer (Maint.+Con.)	0300-0349
						Supervisor (Maint.+Con.)	0350-0449
						Tower Wagon	0450-0459
						Reserved	0460-0599
						TRS	0600-0999
						Officers	0600-0649
						Supervisors	0650-0749
						Driver	0750-0999
						Reserved	1000-9999
	91	99	25	8	0	4	Engineering	0000-9999
							Officer (Maint.+Con.)	0000-0099
							Supervisors (Maint.+Con.)	0100-0299
							Reserved	0300-9999
	91	99	25	8	0	5	Operating	0000-9999
							Officer	0000-0099
							Supervisor	0100-0299
							Guard	0300-0599
							Station Master	0600-0899
							Reserved	0900-9999
	91	99	25	8	0	6	Mechanical	0000-9999
							C & W	0000-0399
							Officer	0000-0049
							Supervisor	0050-0199
							Reserved	0200-0399
							Power	0400-0699
							Officer	0400-0449
							Supervisor	0450-0499
							Driver	0500-0689
							ART	0690-0699
							Diesel	0700-0999
							Officer	0700-0749
							Supervisor	0750-0799
							Reserved	0800-9999
	91	99	25	8	0	7	S &T	0000-9999
							Officer (Maint.+Con.)	0000-0049
							Supervisors (Maint.+Con.)	0050-0249
							Reserved	0250-9999
	91	99	25	8	0	8	Stores	0000-9999
							Officer (Maint.+Con.)	0000-0049
							Supervisors (Maint.+Con.)	0050-0299

Eastern Railway HQ							Reserved	0300-9999
	91	99	25	8	0	9	Accounts	0000-0999
							Officer	0000-0999
							(Maint.+Con.)	
							Supervisors	0100-0299
							(Maint.+Con.)	
							Reserved	0300-9999
Eastern Railway Howrah Division	91	99	25	8	1	Same as HQ	Same as HQ	Same as HQ
Eastern Railway Asansol Division	91	99	25	8	2	Same as HQ	Same as HQ	Same as HQ
Eastern Railway Sealdah Division	91	99	25	8	3	Same as HQ	Same as HQ	Same as HQ
Eastern Railway Malda division	91	99	25	8	4	Same as HQ	Same as HQ	Same as HQ

Numbering scheme for MSISDN number is for Eastern Railway for MSISIDN numbers of other railways, ZONE code will be different as mentioned below.

Railway	ZONE
Central Railway	10
East Central Railway	15
East Coast Railway	20
North Central Railway	30
North Eastern Railway	35
North Western Railway	40
North East Frontier Railway	45
Northern Railway	50
South Central Railway	55
South East Central Railway	60
South Eastern Railway	65
South Western Railway	70
Southern Railway	75
West Central Railway	80
Western Railway	85

Besides two digit Zone code, one digit has been allotted to distinguish zonal headquarter and divisions, i.e. 0 for headquarter, 1 for first division, 2 for second division and so on. Similarly one digit has been identified for various departments in Zonal headquarter and divisions, i.e. 0 for Administration, 1 for Personnel & Commercial Deptt, 2 for Security & Medical Deptt, and so on.

3. Short Codes and Call Type 1 (CT 1):

Location Dependent Addressing (LDA) and Integrated Acknowledgment Center (IAC)

Digits Family	Digits Range		Digits #	Remarks
	From	To		
1 LDA	1200	1200	4	Route to most appropriate Primary Controller
	1300	1300	4	Route to Secondary Controller
	1301	1301	4	Route to C & W Control
	1302	1302	4	Route to Engineering Control
	1303	1303	4	Route to Traction Power Control
	1304	1304	4	Route to S&T Control
	1305	1305	4	Route to Security Control
	1306	1306	4	Route to Commercial Control
	1400	1400	4	Route to Power Controller
1 IAC	1612	1612	4	High priority call confirmations including Railway Emergency Calls
Short Codes	299	299	3	Train Groups: Emergency Call
	569	569	3	Trackside Maintenance Groups: Emergency Call
	599	599	3	Shunting Groups: Emergency Call

NOTE: 1201 to 1599 can be used for other secondary controllers.

4. Train Function Number (9 Digits) (Call Type 2):

CT (1 Digit)	Day (1 Digit) (Schedule originating day of train)	Train Running Number (5 Digit) XXXXX	Function Code (2 Digit)	Remarks
2	1-Monday	First Four digits will be as per train number and last digit will for type of train i.e. schedule train, link train or summer special train	01	Leading Driver
	2- Tuesday		10	Chief Conductor
	3-Wednesday		20	Catering Staff Chief
	4-Thursday		30	Railway security services chief
	5-Friday		80	Guard
	6-Saturday			
	7-Sunday			

NOTE:
XXXX = Four Digit Train Number. The last digit Y will be some numeric depending on the type of train i.e.
Y = 0 for scheduled trains
Y = 1 for link trains
Y = 2 for summer special/ holiday special trains.

5. Engine Function Number (11 Digits) (Call Type 3):

CT (1 digit)	Zone (2 digit)	Engine Number (6 Digit)	Function Code (2 Digit)	Remarks
3	As per ZONE Code of MSISDN	Last five digits will be as per the number of engine and first digit will be zero.	01	Leading Driver
			80	Guard

NOTE:

Goods trains can be identified by Engine Function Number.

6. Voice Broadcast Service (VBS) & Voice Group Call Service (VGCS) Number Plan (10 digits):

Call Type (CT) 50 for Group Call and Call Type (CT) 51 for Broadcast Call.

Call Type (CT) (2 digit)	Service Area Indicator (SA) (5 digits)	Group ID (GID) (3 digit)	Remarks
50 or 51	LLL03 (First Service area) Note: LLL is Location Number of Service Area. Zone = 2 digit. Division = 1 digit same as MSISDN. For example, for ER/HWH LLL = 251, for ER/SDAH LLL=252	200	Train Group: Drivers
		201	Train Group: Conductors
		202	Train Group: Catering
		203	Train Group: Guards
		204	Train Group: Security
		205	Accident Relief Train Group
		206	Emergency Doctor Group
		207-298	Reserved
		299	Train Group: Emergency Call
		500	Default shunting group
		501-520	Reserved for other shunting groups
		530	Station Staff (SM) group
		531	Security staff group
		539	Station and security staff: emergency call
		560	Engg. trackside maintenance group
		561	S&T maintenance group
		562	Electrical Maintenance group
		563	Mechanical maintenance group
		569	Trackside Maintenance group: Emergency Call
		570	Controller group
		579	Controller Group: Emergency call
		599	Shunting group: Emergency call
50 or 51	LLL01 (Second Service area)	DO	DO
50 to 51	LLL02-LLL99 (reserved for other	DO	DO

	service areas in a Division of a Zone)		

50: Group call in the defined service area.
51: Broadcast call in the defined service area.

7. Maintenance and Shunting Team Numbers (Call Type 6):

CALL TYPE (CT)	LOCATION NUMBER (LLLLL) (5 Digit)	FUNCTION CODE, FC (TT, Y, XX) (4 Digit)	Remarks
6	LLLLL is location number where Called Party is registered.	TT=5 for Shunting Team	TT= Team Type (1 Digit)
		TT=6-9 used for Maintenance Teams	
		TT=6 (S&T Maintenance Team-Signal and Telecom)	
	Zone=2 digit, Division=1 digit same as MSISDN. For two LL as 00 Last Three LLL as Zone and Division	TT=7 (Electrical General, TRD, TRS)	
		TT=8 (Mechanical C&W, Diesel, Power)	
		TT=9 (Engineering P Way & Works)	
	For example		
	00250=ER/HQ	Y=0 (TT=5) for Shunting Leader	Y= Team Member Function (1 Digit)
	00251=ER/HWH	Y=1-3 for Shunting Team Member	
	00252=ER/SDAH	For TT=6-9, Y=0-9 is available for team leader and members	
	00253=ER/ASN		
	00254=ER/MLDT	XX=00-99 available as team number for TT=6-9	XX=Team Number (2 Digit)
		FC for Maintenance team Number	
		6 0 00 (1st S&T maintenance team leader)	
		6 1 00 (1st S&T maintenance team-1st member)	
		6 2 00 (1st S&T maintenance team-2nd member)	
		6 0 01 (2nd S&T maintenance team-leader)	
		6 1 01 (2nd S&T maintenance team –Leader)	
		6 2 01 (2nd S&T maintenance team-2nd member)	
		Same pattern will be applicable for other teams also.	

8. Functional Structured Number (FSN) for Train Controller (Call Type 7):

Digits Family	Digits Range		Digits #	Remarks
	From	To		
FSN	7 LLLLL 01	7 LLLLL 01	8	Controller 1
FSN	7 LLLLL 02	7 LLLLL 02	8	Controller 2
FSN	7 LLLLL 03	7 LLLLL 03	8	Controller 3
FSN	7 LLLLL 04	7 LLLLL 04	8	Controller 4
FSN	7 LLLLL 11	7 LLLLL 99	8	Controller 5

LLLLL (5 digits) reserved for Location Number as specified in Call Type 8. For example: Zone + Division Code of HWH is 251. Therefore LLLLL for HWH Division of Eastern Railway will be 00251. Thus Primary Controller Functional Structured Number will become 70025101 (8 Digits).

APPENDIX – II

Details of Network Sub-system (NSS) of

MTRC System of Indian Railways

MSC Make: Nokia Solutions and Networks (NSN)
Model: D900
Version: SR14/CS6.0
Capacity: 4K
Country of Manufacture: NSN Germany
Interfaces and ConnectivityDetails:

Integrated MSC/HLR Node interfaces	E1 ISUP	E1 PRI	SS7 Channelized	SS7 V.35
BSS (A Interface)	19		2	
PSTN	3		2	
IWF	2			
SCP			2	
Railways Fixed Network		3		
Call Recording System	4		2	
Total	28	3	8	2

डेडीकेटेड फ्रेट कोरीडोर

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: CP-203

Issued on: **30-03-2015**

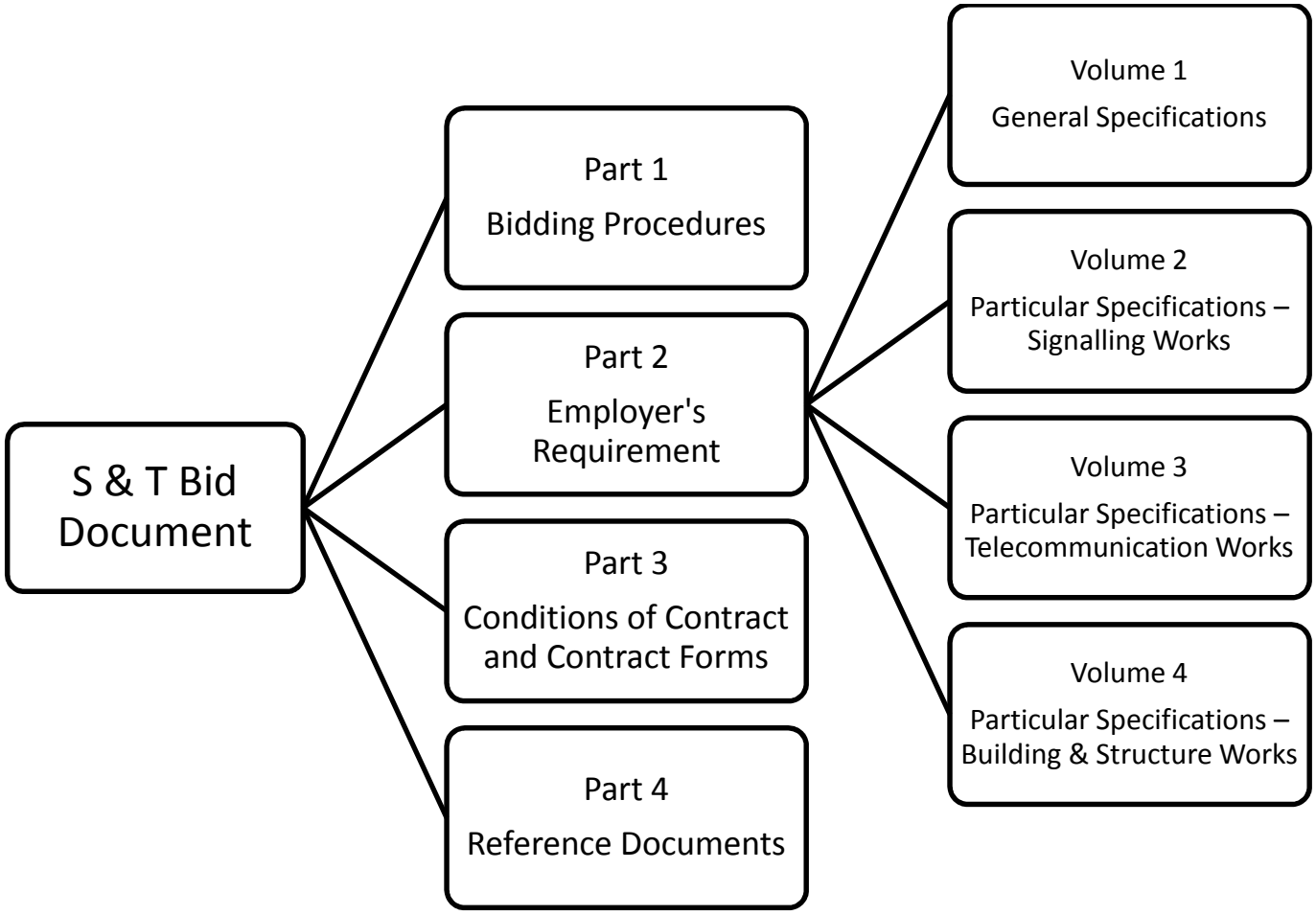
ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

Part 2, Section VI, Volume 4,
Particular Specifications
Building & Structure Works

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)

COUNTRY: **INDIA**

30.03.2015


S & T Bid Document
Part 1
Bidding Procedures
Part 2
Employer's Requirement
Part 3
Conditions of Contract and Contract Forms
Part 4
Reference Documents
Volume 1
General Specifications
Volume 2
Particular Specifications – Signalling Works
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Part 3 – Conditions of Contract and Contract Forms

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Section VIII. Particular Conditions

- Appendix to Tender

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1. Alignment Plans, Yard Plans and Building Plans
2. DFCCIL-Environmental Assessment Report–October 2013
3. DFCCIL-Resettlement Action Plan–August 2013
4. DFCCIL-SHE Manual

PARTICULAR SPECIFICATIONS:
BUILDING & STRUCTURE WORKS

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CHAPTER 1: Objective and Scope of Works

1.1 Objective

1.1.1. The work involved in this bid is Design, Construction, Testing and Commissioning of the service buildings and structures for Signalling Equipment Rooms(SERs), Telecommunication Equipment Rooms(TERs) and Signalling & Telecommunication (S&T) Power Supply Equipment Rooms at Auto Location Huts, LC Gates, Interfacing IR Stations and GSM-R Locations in EDFC Phase-2 by the Contractor in the manner and time stipulated in the Contract and to achieve the standard, performance & functionality specified in the Contract.

1.2 Scope of Works

1.2.1 Design and Construction of Service Buildings for SERs, TERs and S&T Power Supply Equipment Rooms at Auto Location Huts, LC Gates, Interfacing IR Stations and GSM-R Locations.

1.2.2 TER shall preferably be co-located with SER and common S&T Power Supply Equipment Rooms shall be constructed for housing Signalling Power Supply Equipment and Telecom Power Supply Equipment. If it is not possible to co-locate SER and TER, the size of independent Signalling Power Supply Equipment Room and Telecom Power Supply Equipment Room shall be determined by Contractor in consultation with Engineer during design stage to meet the requirements of General Specifications and Particular Specifications.

1.2.3 The work of Design and Construction of Station Buildings, Staff Quarters and other service buildings viz. Integrated Maintenance Depots (IMD), Integrated Maintenance Sub Depots (IMSD), Guest Houses, Club/Institute, Gate Lodges etc. in EDFC Phase-2 shall be executed by Other Contractor(s). However, the necessary co-ordination for such buildings shall be done by this Contractor.

1.2.4 The E&M Works in all Service Buildings and Staff Quarters in EDFC Phase-2 will be designed and constructed by Other Contractor(s). However, the necessary co-ordination for such buildings shall be done by this Contractor.

1.2.5 Obtaining all necessary approvals from the relevant authorities for design and construction of the Works.

1.2.6 Rectification of the defects in the Permanent Works in a manner and to the standard as stipulated in the Employers Requirement.

1.2.7 In full recognition of the purpose and full acceptance of the obligation, liabilities & risks that may be involved, the Contractor shall undertake the design and construction of the building and structures works including and without limitations the design, construction and removal of all the temporary works and handover the completed works to the employer in a condition in which the Employer shall immediately use the works for the intended purpose and/or to make them available to the Other Contractor(s) who shall commence and carry out their works without delay or disruption.

1.3 Architecture

1.3.1 The architectural design shall include but not be limited to site plans, floor plans, elevations, sections including detailed design and drawings. Structure would have

signature architecture in terms of elevations and other architecture elements including efficient use of green building concepts and implementing sustainable building materials.

1.4 General Design & Construction Criteria

1.4.1 The Signalling & Telecommunication equipment particularly the electronic based equipment are sensitive to dust and the temperature. As such SERs, TERs and S&T Power Supply Equipment Rooms are required to be designed so that there is proper ventilation and the temperature inside the rooms does not raise much above the ambient temperature. These rooms should also be dust resistant so that the performance of the equipment does not degrade during its rated life cycle.

1.4.2 Necessary provision for Air-Conditioning, as required, shall be provided in SERs and TERs.

1.4.3 Environmental friendly material and equipment shall be used to the greatest extent possible.

1.4.4 Durability and Maintenance

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

(2) Exterior wall finishes shall withstand the natural weathering effects with minimal periodic maintenance.

(3) Electrical and mechanical equipment where supplied shall be of a quality and durability, to fully meet the performance and operational requirements described in the Design criteria

1.4.5 Operational Requirements

(1) The Permanent Works near running lines shall be designed to permit the railway to operate satisfactorily at a maximum design speed of 100Km/h for freight trains. The Contractor shall ensure that proposed size and location of permanent works other contractor's works do not violate Schedule of Dimensions (SOD) of EDFC/ Indian Railways.

(2) Although the exact size of the SERs, TERs and S&T Power Supply Equipment Rooms will be determined at the design stage, the minimum carpet area shall be as per drawing in Annexure-1.

(3) The plinth level of Signalling Equipment Rooms, Telecommunication Equipment Rooms and Signalling & Telecommunication Power Supply Equipment Rooms shall be at least 300mm above the Rail Level. The ceiling height of these rooms shall be approximately 3 (three) m above floor level.

(4) All buildings shall be provided with concealed ducts/pipes for wiring of signal and telecom facilities. In addition, ducts shall be provided on the floor for entry/exit of S&T cables and also for power supply. These arrangements shall be made in consultation with other contractors.

(5) Chain Link Fencing shall be provided as per Drawing No. DFCC/CHAIN LINK FENCING/TYPE-001 around SER, TER and S&T Power Supply Equipment Rooms constructed under this Contract. The distance of this Chain Link Fencing

from walls of SER, TER and S&T Power Supply Equipment Rooms shall be decided by Engineer during design stage.

(6) The locations of Permanent Structures shall be decided taking due note of the possible operational requirements in coming years.

(7) The foundations of buildings shall be designed for at least one story more than the requirement.

(8) The site of the work shall be cleared off the shrubs, rank vegetation, grass, bushes and other materials upto adequate depth as required as per site condition and rubbish removed outside the periphery of the area being cleared. The enclosed area between Chain Link Fencing and the building shall then be filled with the earth up to Rail Level as well as compacted by a suitable method as decided by Engineer.

(9) Load due to earth quake (as applicable for the earth quake zone in which station building falls) shall be assessed as per provisions of relevant IS Code with latest amendments/revisions.

(10) In the design and construction of the Works, the Contractor shall, as a fundamental objective and as a priority, ensure that staff and the public will be provided with as safe environment as is reasonably practicable throughout the execution period of the contract.

1.4.6 The Specifications for SERs, TERs and S&T Power Supply Equipment Rooms are given in Table 1:

Table 1: Technical Specifications

Sr. No.	Description	Specifications	Skirting / Dado
1	Signalling & Telecommunication Equipment rooms	Ceramic tile flooring	Same with 100 mm high
2	Signalling & Telecommunication Power Supply Equipment Rooms	Acid Proof tiles for flooring	Same with 2 metre high
3	Doors	Door Frame - Steel section painted with Enamel paint	
		Shutter Door - Water proof flush Door Steel section painted with Enamel paint.	
	Ventilators	Ventilators as per drawing no. DFC/HQ/EN/EC/D-B/MGS – New Bhaupur/S&T/01/2014	
		Grill - steel painted with Enamel paint. .	
4	Internal Finish	Cement Plaster on all walls finished with Colour Wash	
5	External Finish	Cement Plaster on all walls and finished with snowcem paint or equivalent	

Sr. No.	Description	Specifications	Skirting / Dado
6	False Ceilings	600 x 600mm calcium silicate panels for Signal and Telecom. Equipment Room	

1.4.7 Lists Of Drawings:

Annexures	Drawing Names	Drawing Numbers
Annexure-1	Signalling & Telecom Equipment Rooms.	Drawing No- DFC/HQ/EN/EC/D-B/MGS – New Bhaupur/S&T/01/2014

1.5 Contractor's Responsibilities

(1) The Contractor shall be responsible for detailed design, layout, construction, manufacture, supply, installation, testing and commissioning of the buildings, structures and building services wherever applicable under this Contract.

(2) The Contractor shall undertake that the designers shall be available to attend discussions with the Engineer and Employer at all reasonable times during the Contract period. The Designer shall be the same entity as proposed by the Contractor at the time of pre-qualification, unless otherwise approved by the Employer.

(3) Detailed design and drawings of buildings & structures shall be submitted by Contractor for review of Engineer.

(4) The Contractor shall be fully responsible, for the suitability, adequacy, integrity, durability and practicality of the Contractor's proposal.

(5) Wherever there is any inadequacy, insufficiency, impracticality or unsuitability in or of the Employer's Requirements or any part thereof, the Contractor's proposal shall take into account, address such inadequacy, insufficiency, impracticality or unsuitability.

(6) The Contractor shall certify that:-

- The Works have been or shall be designed, manufactured, installed and otherwise constructed to the applicable standards available using proven upto-date good practice.
- The Works shall, when completed, comply with enactments and regulations relevant to the Works.
- The design of the Works have taken or shall have taken full account of the effects of the intended manufacturing and installation methods, Temporary works and Contractor's equipment.

(7) The Building Works shall comply with Indian standards and IR regulations and standards as set out in this document.

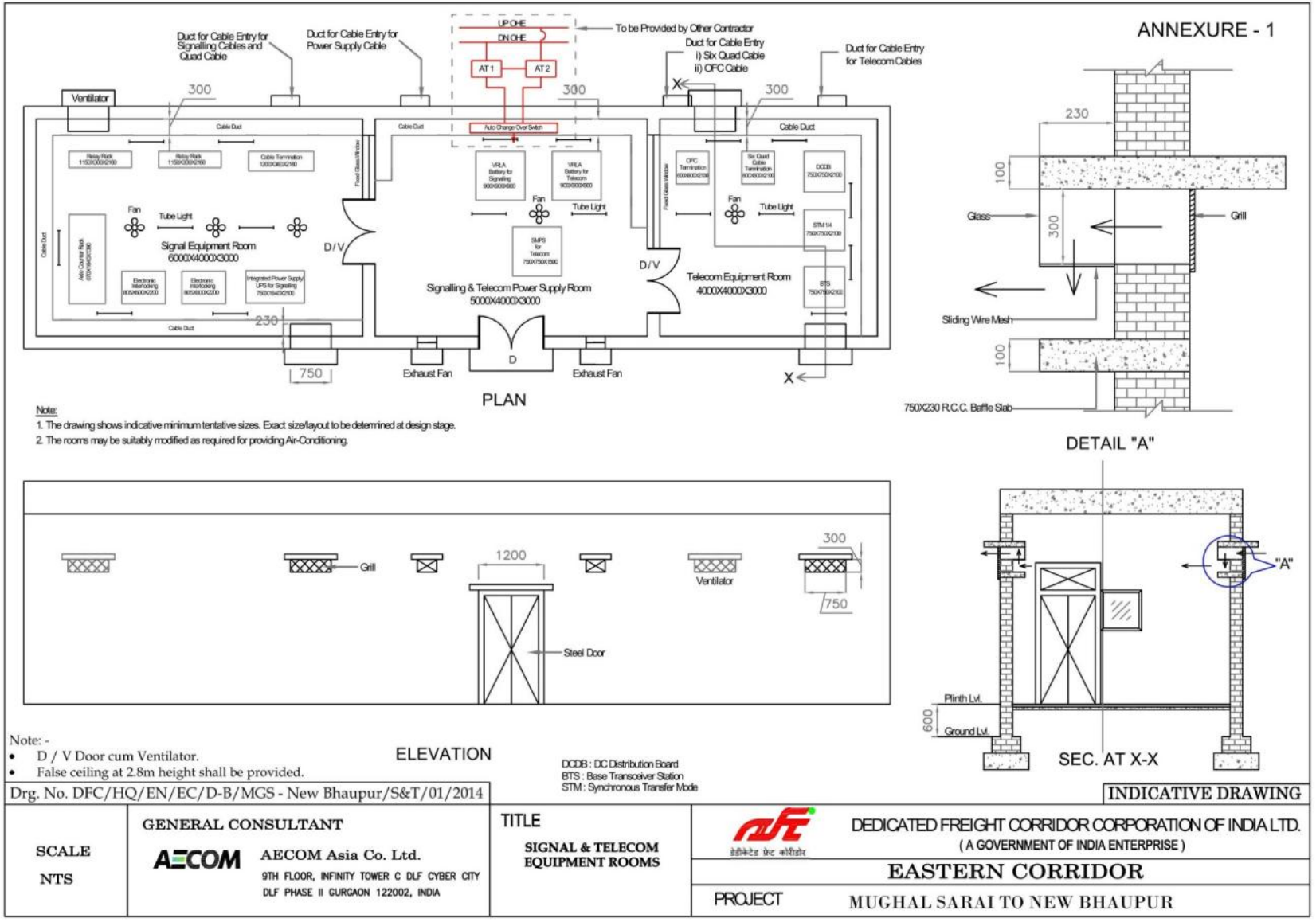
1.6 Aesthetics

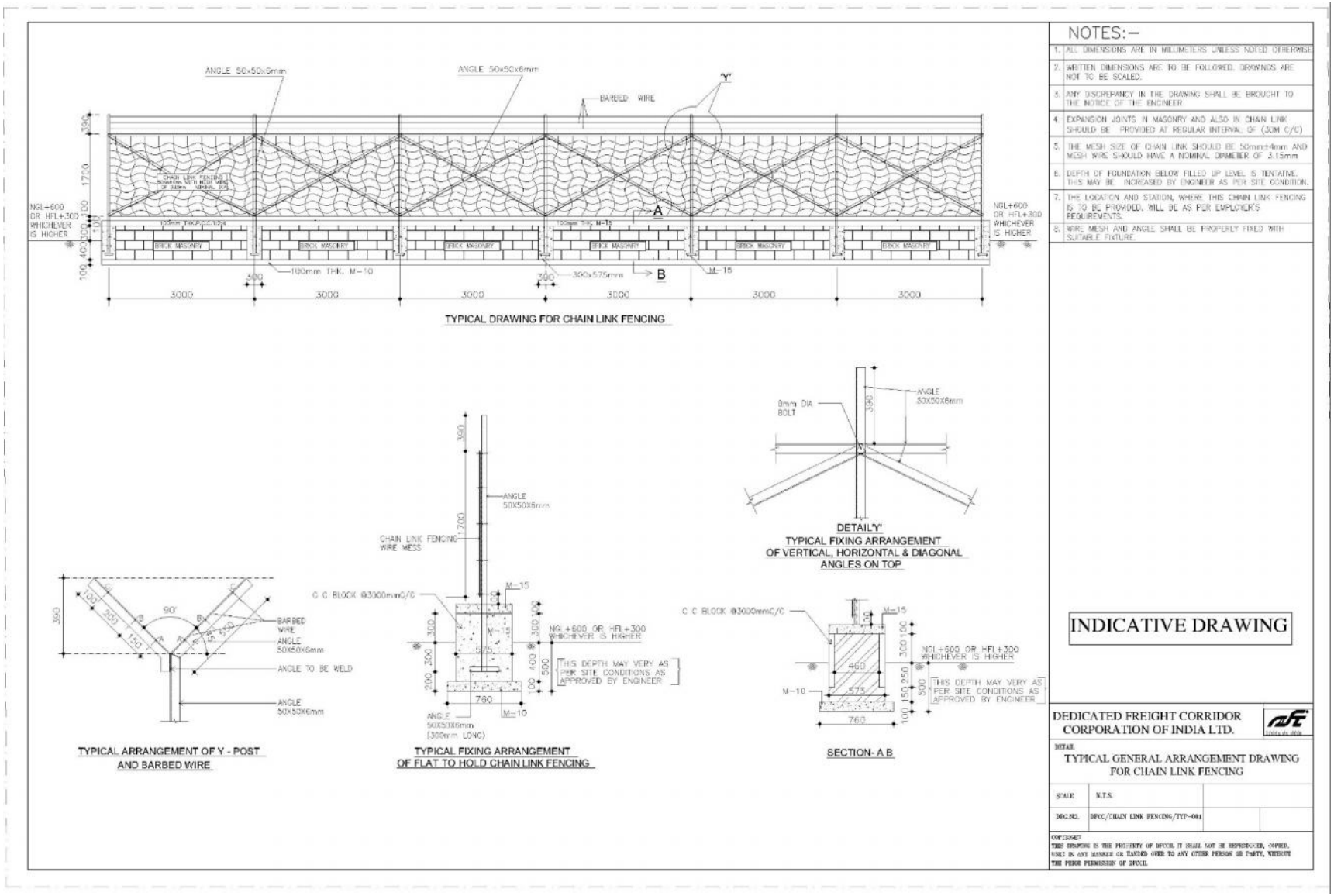
1.6.1 The permanent works shall be designed to achieve an aesthetic character and provide a feeling of design commonality throughout the project.

1.7 Quality Control

1.7.1 Quality control aspects shall be kept in mind during the Design/construction and testing & commissioning phase, requirement for which has been specified at appropriate places in the bidding document.

End of chapter


ANNEXURE - 1
Duct for Cable Entry for Signalling Cables and Quad Cable
Duct for Cable Entry for Power Supply Cable
UP OHE
DN OHE
AT 1
AT 2
To be Provided by Other Contractor
Duct for Cable Entry
i) Six Quad Cable
ii) OFC Cable
Duct for Cable Entry for Telecom Cables
Ventilator
300
Cable Duct
Auto Change Over Switch
Fan
Tube Light
Signal Equipment Room
6000X4000X3000
D/V
Signalling & Telecom Power Supply Room
5000X4000X3000
Telecom Equipment Room
4000X4000X3000
230
750
Exhaust Fan
D
PLAN
Note:
1. The drawing shows indicative minimum tentative sizes. Exact size/layout to be determined at design stage.
2. The rooms may be suitably modified as required for providing Air-Conditioning.
Grill
1200
Steel Door
Ventilator
Note: -
• D / V Door cum Ventilator.
• False ceiling at 2.8m height shall be provided.
ELEVATION
DCDB : DC Distribution Board
BTS : Base Transceiver Station
STM : Synchronous Transfer Mode
100
Glass
Sliding Wire Mesh
750X230 R.C.C. Baffle Slab
DETAIL "A"
Plinth Lvl.
Ground Lvl.
600
SEC. AT X-X
INDICATIVE DRAWING
Drg. No. DFC/HQ/EN/EC/D-B/MGS - New Bhaupur/S&T/01/2014
GENERAL CONSULTANT
AECOM Asia Co. Ltd.
9TH FLOOR, INFINITY TOWER C DLF CYBER CITY
DLF PHASE II GURGAON 122002, INDIA
SCALE
NTS
TITLE
SIGNAL & TELECOM EQUIPMENT ROOMS
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)
EASTERN CORRIDOR
PROJECT
MUGHAL SARAI TO NEW BHAUPUR


NOTES:–
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. WRITTEN DIMENSIONS ARE TO BE FOLLOWED. DRAWINGS ARE NOT TO BE SCALED.
3. ANY DISCREPANCY IN THE DRAWING SHALL BE BROUGHT TO THE NOTICE OF THE ENGINEER.
4. EXPANSION JOINTS IN MASONRY AND ALSO IN CHAIN LINK SHOULD BE PROVIDED AT REGULAR INTERVAL OF (30M C/C)
5. THE MESH SIZE OF CHAIN LINK SHOULD BE 50mm±4mm AND MESH WIRE SHOULD HAVE A NOMINAL DIAMETER OF 3.15mm
6. DEPTH OF FOUNDATION BELOW FILLED UP LEVEL IS TENTATIVE. THIS MAY BE INCREASED BY ENGINEER AS PER SITE CONDITION.
7. THE LOCATION AND STATION, WHERE THIS CHAIN LINK FENCING IS TO BE PROVIDED, WILL BE AS PER EMPLOYER'S REQUIREMENTS.
8. WIRE MESH AND ANGLE SHALL BE PROPERLY FIXED WITH SUITABLE FIXTURE.
ANGLE 50x50x6mm
ANGLE 50x50x6mm
BARBED WIRE
'Y'
A
B
NGL+600 OR HFL+300 WHICHEVER IS HIGHER
BRICK MASONRY
100mm THK. M-10
300x575mm
M-15
3000
TYPICAL DRAWING FOR CHAIN LINK FENCING
DETAIL'Y'
TYPICAL FIXING ARRANGEMENT OF VERTICAL, HORIZONTAL & DIAGONAL ANGLES ON TOP
BARBED WIRE
ANGLE 50X50X6mm
ANGLE TO BE WELD
TYPICAL ARRANGEMENT OF Y - POST AND BARBED WIRE
CHAIN LINK FENCING WIRE MESS
C.C BLOCK @3000mmC/C
THIS DEPTH MAY VERY AS PER SITE CONDITIONS AS APPROVED BY ENGINEER
ANGLE 50X50X6mm (300mm LONG)
TYPICAL FIXING ARRANGEMENT OF FLAT TO HOLD CHAIN LINK FENCING
SECTION- A B
INDICATIVE DRAWING
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.
TYPICAL GENERAL ARRANGEMENT DRAWING FOR CHAIN LINK FENCING
SCALE N.T.S.
DRG.NO. DFCC/CHAIN LINK FENCING/TYP-001
COPYRIGHT
THIS DRAWING IS THE PROPERTY OF DFCCIL. IT SHALL NOT BE REPRODUCED, COPIED, USED IN ANY MANNER OR HANDED OVER TO ANY OTHER PERSON OR PARTY, WITHOUT THE PRIOR PERMISSION OF DFCCIL

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, TESTING AND COMMISSIONING OF SIGNALLING, TELECOMMUNICATION AND ASSOCIATED WORKS OF DOUBLE TRACK RAILWAY LINES UNDER CONSTRUCTION ON A DESIGN BUILD LUMP SUM BASIS FOR MUGHALSARAI - NEW BHAUPUR SECTION OF EASTERN DEDICATED FREIGHT CORRIDOR

SIGNALLING AND TELECOMMUNICATION WORKS

CONTRACT PACKAGE: 203

Issued on: **30-03-2015**

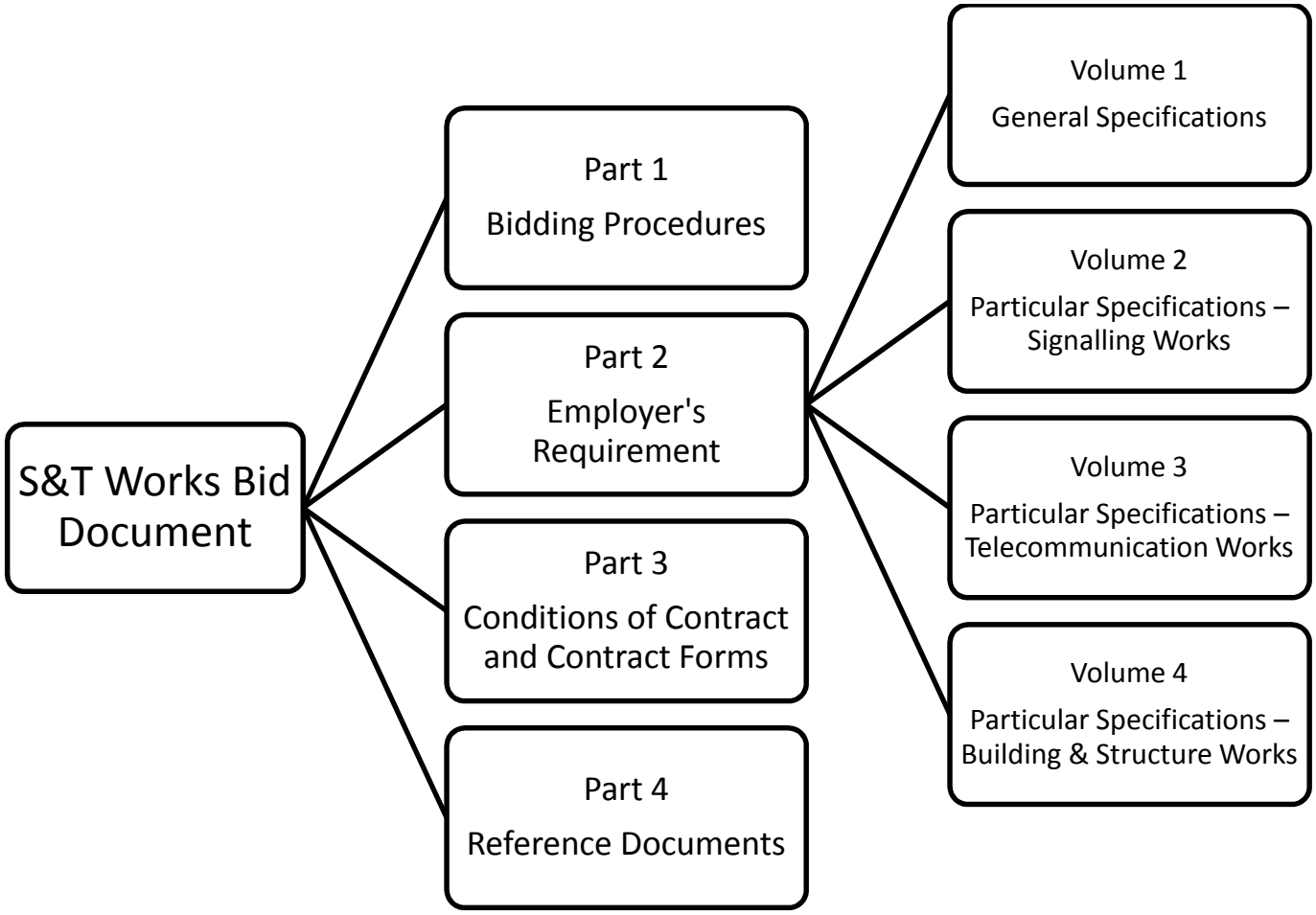
ICB No.: HQ/S&T/EC/D-B/Mughalsarai – New Bhaupur

Part-3, Conditions of Contract and Contract Forms

EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)
MINISTRY OF RAILWAYS

COUNTRY: **INDIA**

30.03.2015


S&T Works Bid Document
Part 1
Bidding Procedures
Part 2
Employer's Requirement
Part 3
Conditions of Contract and Contract Forms
Part 4
Reference Documents
Volume 1
General Specifications
Volume 2
Particular Specifications – Signalling Works
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Section VI. Employer's Requirement

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Volume 2: Particular Specifications – Signalling Works

Volume 3: Particular Specifications – Telecommunication Works

Volume 4: Particular Specifications – Building & Structure Works

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PART 3

Conditions of Contract

&

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Section VII. General Conditions (GC)
As per FIDIC Yellow Book 1999-Edition

GENERAL CONDITIONS OF CONTRACT (GC)
REFER TO

The conditions of Contract comprise the "General Conditions" which form part of the conditions of Contract for Plant and Design Build first edition 1999 published by the Federation Internationale Des Ingenieurs – Conseils (FIDIC) and the following "Particular Conditions" which include amendments and addition to such General Conditions.

Copies of the above FIDIC publication i.e. "Conditions of Contract for Plant and Design Build" can be obtained from

International Federation of Consulting Engineers
FIDIC Bookshop – Box- 311 – CH – 1215 Geneva 15 Switzerland
Fax: +41 22 799 49 054
Telephone: +41 22 799 49 01
E-mail: fidic@fidic.org
www.fidic.org

Section VIII. Particular Conditions

The Conditions of Contract comprise the "**General Conditions**", which form part of the "Conditions of Contract for Plant and Design Build for Electrical and Mechanical, and for Building and Engineering Works designed by the Contractor", First Edition, 1999 published by the Fédération Internationale des Ingénieurs-Conseils (**FIDIC**), and the following "**Particular Conditions**", which include amendments and additions to such General Conditions. The General Conditions are incorporated herein by reference only and are not set out at length. The Contractor is deemed to have obtained for himself and read and fully understood the General Conditions in their entirety. The following Particular Conditions shall supplement the General Conditions in Section VII. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions.

Clause	**PROVISIONS**
Sub-Clause 1.1.3.1	**Insert the words** "Second Stage" before the word "Tender" in second line of the Sub-Clause 1.1.3.1.
Sub-Clause 1.1.3.10	**Insert additional Sub-Clause 1.1.3.10** "Milestone" means the completion of a part of the Works, or the occurrence of an identified event.
Sub-Clause 1.1.3.11	**Insert additional Sub-Clause 1.1.3.11** "Stage" means the part of the Works identified as such and more particularly described in the Price Schedules, Part1 Section IV Bidding Forms.
Sub-Clause 1.1.3.12 Reference to Period	**Insert additional Sub-Clause 1.1.3.12:** **"**Reference to period" means period commencing 'from' a specified day or date and 'till' or 'until' a specified day or date shall include both such days and dates."
Sub-Clause 1.1.6.9	**Delete the existing clause and substitute with the following:** **Variation** means any change to the Employer's Requirements with reference to change in Scope of Works, Design Criteria & Specifications and Criteria for the Testing & Performance of the completed Works specified in the Employer's Requirements or the Works, which is instructed or approved as a variation under clause 13 [Variations and Adjustment].
Sub-Clause 1.1.6.10	**Insert the following Sub-Clause 1.1.6.10:**

General Clauses Act 1897	"Any word or expression used in this Contract shall, unless otherwise defined or construed in this Contract, bears its ordinary English meaning and, for these purposes, the General Clauses Act 1897 shall not apply."
Sub-Clause 1.2. Interpretation	**Replace "." at the end of sub-paragraph (d) with ";"** **Insert the following sub-paragraphs after sub-paragraph (d):** (e) the word "tender" is synonymous with "bid", and "tenderer" with "bidder" and the words "tender documents" with "bidding documents".
Sub-Clause 1.3 Communication	**Add the following paragraph at the end of this Sub-Clause:** "In this Contract, unless the context otherwise requires, any Contract, consent, approval, authorisation, notice, communication, information or report required under or pursuant to this Contract from or by any Party or the Engineer shall be valid and effective only if it is in writing under the hand of a duly authorised representative of such Party or the Engineer, as the case may be, in this behalf and not otherwise"
Sub-Clause 1.5	**Delete sub paragraphs (a) to (h) and replace with the following:** 1) The Contract Agreement; 2) Letter of Acceptance; 3) Minutes of meeting of pre-award clarifications / negotiations after opening of the Second Stage Bid, if any; 4) Addenda to Bidding Documents, if any; 5) (i) Letter of Bid-(Two Stage Bidding, Second Stage Bid), (ii) Appendix to Bid (Percentage Breakup of Lump Sum Bid Price for local & foreign currencies (iii) Price Schedules submitted by the Contractor; 6) Appendix to Tender; 7) Particular Conditions;

	8) General Conditions; 9) Memorandum titled 'Changes Required Pursuant to First Stage Evaluation'; 10) (i) Employer's Requirements; (ii) Letter of Bid (First Stage Bidding) 11) Contractor's Updated Technical Proposal; 12) Part 4 (Reference Documents) of Bidding document; and 13) Any other documents forming part of the Employer's requirements and Bidding documents.
Sub-Clause 1.7 Assignment	**Delete Sub-Clause 1.7 (a)**
Sub-Clause 1.9 Errors in Employer's Requirements	**Delete Sub-Clause 1.9 and replace with:** "If the Contractor suffers delay and/or incurs Cost as a result of an error in the Employer's Requirements with reference to purpose, scope, design and /or other technical criteria for the works and an experienced contractor exercising due care would not have discovered the error when scrutinizing the Employer's Requirements with respect to purpose, scope, design and/or other technical criteria for the works under Sub-Clause 5.1 [General Design Obligations], the Contractor shall give notice to the Engineer and shall be entitled subject to Sub-Clause 20.1 [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.4 [Extension of Time for Completion], and (b) payment of any such Cost plus reasonable profit, which shall be included in the Contract Price. After receiving this notice, the Engineer shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine (i) whether an experienced Contractor could not have discovered the error? (ii) if the answer to the matter stated above in paragraph (i) is yes, to what extent the Contractor could not reasonably have discovered the error; and (iii) the matters described in sub-paragraphs (a) and (b)

	above to the extent under paragraph (ii) above."
Sub-Clause 1.14 Joint and Several Liability	**Delete Sub-Clause (b) and replace with:** "In case of a joint venture or consortium or group of two or more persons performing the Contract, one of the members shall be nominated as the lead partner, who shall be the point of contact for the Employer. Each member of the joint venture or consortium or group of two or more persons shall furnish a power of attorney in favour of the lead partner to take all actions on behalf of the joint venture or consortium and bind the joint venture consortium. However, the nomination of such lead partner shall not in any way affect the joint and several liability of the joint venture or consortium members under (a) above."
New Sub-Clause 1.15 Inspections and Audits by the Bank	**Add New Sub-Clause 1.15:** "The Contractor shall permit, and shall cause its Subcontractors and sub-consultants to permit, the Bank and/or persons appointed by the Bank to inspect the Site and all accounts and records relating to the performance of the Contract and the submission of the Bid, and to have such accounts and records audited by auditors appointed by the Bank if requested by the Bank. The Contractor's and its Subcontractors' and sub-consultants' attention is drawn to Sub-Clause 1.16 [Fraud and Corruption] which provides, inter alia, that acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under Sub-Clause 1.15 constitute a prohibited practice subject to contract termination (as well as to a determination of ineligibility pursuant to the Bank's prevailing sanctions procedures)."
New Sub-Clause 1.16 Fraud & Corruption	**Add New Sub-Clause 1.16:** "If the Employer determines that the Contractor and/or any of its personnel, or its agents, or its Subcontractors, sub-consultants, services providers, suppliers and/or their employees has engaged in corrupt, fraudulent, collusive coercive, or obstructive practices, in competing for or in executing the Contract, then the Employer may, after giving 14 days notice to the Contractor, terminate the Contractor's employment under the Contract and expel him from the Site, and the provisions of Clause 15 shall apply as if such

	expulsion had been made under Sub-Clause 15.2. For the purposes of this Sub-Clause, (i) "corrupt practice" is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party[1]; (ii) "fraudulent practice" is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation[2]; (iii) "collusive practice" is an arrangement between two or more parties[3] designed to achieve an improper purpose, including to influence improperly the actions of another party; (iv) "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party[4] or the property of the party to influence improperly the actions of a party; (v) "obstructive practice" is (aa) deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or (bb) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided

1 "Another party" refers to a public official acting in relation to the procurement process or contract execution]. In this context, "public official" includes World Bank staff and employees of other organizations taking or reviewing procurement decisions.

2 "Party" refers to a public official; the terms "benefit" and "obligation" relate to the procurement process or contract execution; and the "act or omission" is intended to influence the procurement process or contract execution.

3 "Parties" refers to participants in the procurement process (including public officials) attempting to establish bid prices at artificial, non competitive levels.

4 "Party" refers to a participant in the procurement process or contract execution.

	for under Sub-Clause 1.15."
Sub-Clause 2.1 Right of Access to Site	**Insert the words** "Formation, Track" between the words "plant" and "or" in line 5th of paragraph 1. **Delete Sub-clause(b) in para 3.**
Sub-Clause 3.1 Engineer's Duties and Authorities	Delete 4th paragraph "However, whenever …… given approval" of this Sub-Clause. Add the following at the end of this Sub-Clause: "Notwithstanding anything contained hereinabove, the Engineer is required to obtain specific written approval of the Employer before exercising specific authorities as listed below: i) Consenting to proposed Subcontractors / Specialized Sub-contractors pursuant to Sub-Clause 4.4 (b); ii) Giving consent to the Contractor's proposed Designer pursuant to Sub-Clause 5.1; iii) Giving approvals to the Contractor's documents under Sub-Clause 5.2 as specified in Employer's Requirement; iv) Determination of any additional payment in accordance with Sub-Clause 3.5 read with Sub-Clause 2.5 & 20.1. v) Determination of Extension of Time for Completion in accordance with Sub-Clause 8.4 read with Sub-Clause 20.1; vi) Taking action in connection with variations in the Employer's Requirements which have been initiated by the Employer. vii) Issuing of Taking-Over Certificate pursuant to Clause 10; viii) Instructing or approving Variations pursuant to Sub-Clauses 13.1, 13.2 and 13.3 except if the variation is within a limit of 0.1% of original contract price in a single instance and combined with all variation orders previously issued, increase the original Contract Price by less than 2%.; The Employer shall, on the best effort basis, give its decision on Engineer's proposal of variation within 21

	(twenty one days) of the receipt of the proposal. Notwithstanding the obligation of obtaining the above stated approvals, if in the opinion of the Engineer an emergency, affecting the safety of life or of the works or of adjoining property or track, occurs, the Engineer may, without relieving the Contractor of any of his duties and obligations under the Contract, instruct the Contractor to execute all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. In case the emergency mentioned above occurs on account of failure of Contractor, by way of not adhering to the sound industry practice or not taking adequate safety precautions, then no amounts shall be paid to the Contractor for attending to such emergencies."
Sub-Clause 4.2 Performance Security	**Add the following after "**given**" at the end of para 4.2(d)**: "in which event the Employer shall forfeit the amount of the Performance Security as indicated in Sub-Clause 15.4." **Delete paragraph 5 of Sub-Clause 4.2 "The Employer … claim." and substitute with the following:** "In case the Employer makes a claim on the Performance Security, which it was not entitled to make, the Employer shall forthwith refund such amount of claim to the Contractor."
Sub-Clause 4.4 Subcontractors	"**Delete the first line of Sub-Clause 4.4 and substitute with the following:** "The Contractor shall not subcontract Works of value more than 30% of the Accepted Contract Amount in addition to the Works for which Specialized Subcontractor(s) are named in the Contract." **Add the following at the end of the Sub-Clause:** "The Employer at his discretion may permit the replacement of Specialized Subcontractor(s), named in the Contract, provided new Specialized Subcontractor(s) have required qualification."
Sub-Clause 4.7 Setting Out	**Delete paragraph 2, 3 & 4 of Sub-Clause 4.7 and substitute with the following:** "Accuracy of these specified items of reference shall be

	deemed to have been verified by the Contractor. Accordingly, the Contractor shall have no right to claim towards time or cost caused due to errors in these specified items of reference."
Sub-Clause 4.10 **Site Data**	Add at the end of **paragraph 1 of Sub-Clause 4.10.** "Accordingly, the Contractor shall have no claim in this regard." **In paragraph 2 of Sub-Clause 4.10.** **Delete** the words "To the extent which was practicable (taking account of cost and time)". **Start** the word "the" with a capital letter. **Delete** "To the same extent" from the fourth line and **Start** the word "the" with a capital letter.
Sub-Clause 4.11 Sufficiency of the Accepted Contract Amount	Add the following after Sub-Clause 4.11 "DFCC project being funded by the World Bank, qualifies for exemption from payment of custom duty and Excise duty on goods supplied/intended to be supplied to the Project in terms of Government of India's Customs notification no. 84/97 – customs dated 11.11.1997 and Central Excise Notification no. 108/95-CE dated 28.08.1995 (read along with all subsequent amendments) respectively, provided the goods brought in to the project are not withdrawn by the supplier or the Contractor. Under various notifications of the Department of Excise and Customs, Government of India, goods brought in to the project funded by the International Bank of Reconstruction and Development (IBRD) and / or awarded after conducting process under the International Competitive Bidding are exempt from Customs and Excise duties and / or are eligible for Deemed Export Benefits, provided the said goods are not withdrawn by the supplier or Contractor. The certificates required for claiming exemption of customs duty and excise duty and / or for claiming deemed export benefits on goods by the Contractor shall be issued by the Employer. The Contractor shall be solely responsible for obtaining such duty exemptions and / or deemed export benefits and in case of failure to avail such benefits for any reasons whatsoever; the Employer shall not reimburse any such duties.

	The above stated certificate(s) shall be issued for the bona fide and reasonable quantities of goods to be used as input in the construction of Works, on the recommendations of the Engineer taking in to account the Work Programme [Sub-Clause 8.3 of the Conditions of Contract] and approved methodology. Any delay in procurement of the goods as a result of any delay, in the issuing of the above mentioned certificates and / or availing the exemptions, shall not be entertained as a reason for granting any Extension of Time for Completion and / or additional cost. Service Tax department vide their Notification No. 25/2012-Service Tax dated 20.06.2012, has exempted the services by way of construction, erection, commissioning, or installation of original works pertaining to railways. The Bidder shall examine to make his own assessment in regard to service tax liability in the Contract. No separate Service Tax reimbursement will be made by the Employer. No customs duty or excise duty or any tax, fee, royalty etc. will be reimbursed by the Employer."
Sub-Clause 4.12 Unforeseeable Physical Conditions	**Delete the Sub-Clause and Substitute with the following:** "In this Sub-Clause, "physical conditions" means man-made or natural physical conditions including sub-surface and hydrological conditions which the Contractor encounters at Site during the execution of the Works. Except as otherwise stated in the Contract: (a) the Contractor accepts total responsibility for having foreseen all difficulties and physical conditions; and (b) the Contract Price shall not be adjusted to take account of any unforeseen physical conditions."
Sub-Clause 4.25 Change of Control	**Insert the following additional Sub-clause 4.25** "Any change in Control of the Contractor, or in case if the Contractor is a JV/consortium of members, any change of Control of any of the members of the JV/consortium, shall require prior approval of the Employer. Such approval shall not be unreasonably withheld, unless, such change in Control, if had taken prior to the date of submission of the bid, would have rendered the Contractor or any such member

	in case the Contractor is a JV/consortium, ineligible to bid for the Project in terms of the Instructions to Bidders or in the opinion of the Employer such change in Control shall jeopardize national security or interest. For the purposes of this clause "Control" shall mean the possession, directly or indirectly, of the power to direct or cause the direction of the management and affairs of such person, whether through the legal and beneficial ownership of more than 50% (fifty per cent) of the voting securities of such person, by agreement or otherwise or the power to elect majority of directors, partners or other individuals exercising similar authority with respect to such person."
Sub-Clause 5.1 General Design Obligations	**Delete Sub-Clause 5.1 and substitute with the following:** "The Contractor shall carry out, and be responsible for, the design of the Works. Design shall be prepared by qualified designers who are engineers or other professionals who comply with the criteria (if any) stated in the Employer's Requirements with reference to purpose, scope, design and/or other technical criteria for the works. Unless otherwise stated in the Contract, the Contractor shall submit to the Engineer for consent the name and particulars of each proposed designer and design Subcontractor. The Contractor warrants that he, his designers and design Subcontractors have the experience and capability necessary for the design. The Contractor undertakes that the designers shall be available to attend discussions with the Engineer at all reasonable times, until the expiry date of the relevant Defects Notification Period. Upon receiving notice under Sub-Clause 8.1 *[Commencement of Works]*, the Contractor shall scrutinise the Employer's Requirements with reference to purpose, scope, design and /or other technical criteria for the works (including design criteria and calculations, if any). Within the period stated in the Appendix to Tender, calculated from the Commencement Date, the Contractor shall give notice to the Engineer of any error, fault or other defect found in the Employer's Requirements with reference to purpose, scope, design and /or other technical criteria for the works. After receiving this notice, the Engineer shall determine whether Clause 13 *[Variations and Adjustments]* shall be applied, and

	shall give notice to the Contractor accordingly. If and to the extent that (taking account of cost and time) an experienced contractor exercising due care would have discovered the error, fault or other defect when examining the Site and the Employer's Requirements with reference to purpose, scope, design and/or other technical criteria for the works before submitting the Tender, the Time for Completion shall not be extended and the Contract Price shall not be adjusted."
Sub-Clause 6.12 Employment of Foreign Nationals	**Add the following New Sub-Clause 6.12:** "The Contractor acknowledges, agrees and undertakes that employment of foreign personnel by the Contractor and/or its Subcontractors may be subject to grant of requisite regulatory permits and approvals including employment/residential visas and work permits, required if any, and the obligation to apply for and obtain the same shall always be of the Contractor. Notwithstanding anything to the contrary contained in the Contract, refusal of or inability to obtain any such permits and approvals by the Contractor or any of its Subcontractors shall not constitute Force Majeure event, and shall not in any manner excuse the Contractor from the performance and discharge of its obligations and liabilities under the Contract. The Employer, on a best effort basis, will provide reasonable assistance in obtaining such visas and permits, but without thereby incurring any liability whatsoever towards the Contractor."
Sub-Clause 7.4 Testing	**Insert the following at the end of this Sub-Clause:** "The Contractor shall not be released from any liability or obligation under the Contract by reason of any such inspection or testing or witnessing of testing, or by the submission of reports of inspection or testing to the Engineer."
Sub-Clause 8.2 Time for Completion	**Delete this Sub-Clause and substitute with the following:** "Whole of the Works shall be completed within 1000 (One Thousand) days from the Commencement Date. **Milestone-1: 360 (Three Hundred Sixty) days from the Commencement Date** Prior to the occurrence of Milestone-1, the Contractor shall

	have commenced the activities of the permanent works entitling him a payment of at least 10% of Accepted Contract Amount. Note: 10% of the Accepted Contract Amount shall not include advance payment made to the contractor as per Clause 14.2 of GC. **Milestone-2: 600 (Six Hundred) days from the Commencement Date** Prior to the occurrence of Milestone-2, the Contractor shall have completed (a) 75% of Laying of Outdoor Signalling & Telecom Cable and their Termination & Testing; and (b) Supply of S&T equipment and its progressive installation entitling him a payment of at least 40% of Accepted Contract Amount. Note: 40% of the Accepted Contract Amount shall not include advance payment made to the contractor as per Clause 14.2 of GC. **Milestone-3: 800 (Eight Hundred) days from the Commencement Date** Prior to the occurrence of Milestone-3, the Contractor shall have completed (a) 90% of Laying of Outdoor Signalling & Telecom Cable and their Termination & Testing; and (b) Supply of S&T equipment and its progressive installation entitling him a payment of at least 65% of Accepted Contract Amount. Note: 65% of the Accepted Contract Amount shall not include advance payment made to the contractor as per Clause 14.2 of GC. **Milestone 4: 1000 days (One Thousand) days from the Commencement Date** Prior to the occurrence of Milestone-4, the Contractor shall have completed all Works required as per the Contract and issue of Taking-Over Certificate pursuant to Clause 10 of the Conditions of Contract.
Sub-Clause 8.3	**Insert the following after 1st sentence in paragraph 1:**

Programme	"Each programme shall take into account the progress of the Works under execution of Civil Works Contracts [Package 201 & 202] as well as that of Electrical Works Contract (Package 204) of the same section under the same Project [Eastern Dedicated Freight Corridor Project-2]." **Delete paragraph 3 of Sub- Clause 8.3** "The Contractor shall …… [Variation Procedure]."
Sub-Clause 8.4 Extension of Time for Completion	**Delete Sub-Clauses (c)** **Delete "(d)" and substitute as under:-** "Unforeseeable shortages in the availability of Goods caused due to changes in laws in accordance with the provisions of Sub-Clause 13.7" **Add Sub-Clause (f)** - A cause of delay in handing over possession of Site in accordance with the provisions of Sub-Clause 2.1
Sub-Clause 8.7 Delay Damages	**Delete Sub-Clause 8.7 and substitute with the following:** "The Contractor shall complete the Works in accordance with the Time for Completion of Works set forth in Sub-Clause 8.2 [Time for Completion]. In the event that the Contractor fails to achieve any Milestone on the date set forth for such Milestone in the Time for Completion, unless such failure has occurred due to Force Majeure or for reasons solely attributable to the Employer, the Contractor shall pay Delay Damages to the Employer in a sum calculated at the rate stated in the Appendix to Tender until such Milestone is achieved; provided that if the construction period for any or all Milestones is extended in accordance with the provisions of this Contract, the dates set forth in the Sub-Clause 8.2 [Time for Completion] shall be deemed to be modified accordingly and the provisions of this Sub-Clause shall apply as if Appendix to Tender has been amended accordingly; provided further that in the event Whole of the Works are completed within the Time for Completion as stated in the Sub-Clause 8.2 [Time for Completion] of the Particular Conditions, the Delay Damages paid under this Sub-Clause shall be refunded by the Employer to the Contractor, but without any interest thereon. It is agreed that recovery of Damages under this Sub-Clause shall be without prejudice to the rights of the Employer under

	this Contract including the right of Termination thereof. The Parties hereby accept that delays cause loss to the public and the national economy for whose benefit the Works is meant, and that the loss is not susceptible to precise measurement. The Parties hereby agree that the rate of Delay Damages agreed in this Clause 8.7 is a reasonable pre-determined amount, and that the Delay Damages are not by way of penalty. Further, the total amount of Delay Damages under Sub-Clause 8.7 shall not exceed the maximum amount of delay damages (if any) stated in the Appendix to Tender."
Sub Clause 8.8 **Suspension of Work**	**Delete Sub-Clause 8.8 and substitute with the following:** "In the event of the failure of the Contractor to duly and effectively perform any of its obligations or to perform proper execution of the Works in accordance with the provisions of this Contract, the Engineer may by notice require the Contractor to suspend forthwith the performance of any obligations under the Contract or the whole or any part of the Works. The Contractor shall, pursuant to the notice under this Sub-Clause, suspend the Works or any part thereof for such time and in such manner as may be specified by the Engineer and thereupon carry out remedial measures to rectify the defects and secure the safety of the suspended works. The Contractor may by notice require the Engineer to inspect such remedial measures forthwith, with a request that the suspension hereunder may be revoked. The Engineer shall either revoke such suspension or instruct the Contractor to carry out such other and further remedial measures as may be necessary and the procedure set forth in this Sub-Clause shall be repeated until the suspension hereunder is revoked. All reasonable costs incurred for maintaining and protecting the Works and remedying the defects during the period of suspension shall be borne by the Contractor. During the period of Suspension, the Employer may at its own discretion, on behalf of the Contractor, undertake to fulfill any of the Contractor's obligations for remedying and rectifying the cause of Suspension. Provided that any cost incurred by the Employer in fulfilling the obligations of the Contractor for the remedying or rectifying the cause of Suspension shall be borne by the Contractor. The Employer shall have the right to deduct any such expense incurred and

	another twenty percent thereof as Damages from any payment due or to be due to the Contractor under the provisions of this Contract. If and to the extent the cause for the suspension is the responsibility of the Contractor, the following Sub-Clauses 8.9, 8.10, and 8.11 shall not apply. The Contractor shall not be entitled to extra cost (if any), incurred by him, during the period of suspension of Work, if such suspension is: **(a)** provided for in the Contract; or **(b)** necessary for proper execution of Woks or by reasons of weather condition or by some default on the part of the Contractor; or **(c)** necessary for the safety of Works or any part thereof; or **(d)** necessary for the safety of adjoining public or other property or safety of the public or workmen or those who have to be at the site; or **(e)** to ensure safety and to avoid disruption of traffic and utilities, as also to permit fast repairs and restoration of any damaged utilities."
Sub-Clause 10.2 Taking Over of Parts of the Works	**Delete the Sub-Clause 10.2 in its entirety.**
Sub-Clause 13.2 Value Engineering	**After the Sub-Clause add the following:** "The value engineering proposal shall not impair the essential character, functions or characteristics of the Work, including service life, economy of operation, ease of maintenance, desired appearance, or design, safety standards would not result in any reduction to the standard, or quality of works, or the performance of the Contractor and his obligations under the Contract. If the proposal of variation as a result of Value Engineering is approved, the reasonable share to be given to the Contractor shall be 30% of the net saving resulted due to Value Engineering."
Sub-Clause 13.3 Variation procedure	**Add the following below the last paragraph:** "For varied works of items due to variation as per Sub-

	Clause 1.1.6.9 determination of adjustment to the Contract Price shall be based on the following: a. Inputs of man-days, machine hours and quantities of materials; b. (i) Prevailing market rates for Materials, hiring of equipment; (ii) Rates being paid by the Contractor for unskilled, semi-skilled and skilled worker as per the records maintained by the Contractor in accordance with the Laws; c. Contractor's overheads and profit at the rate of 15 (fifteen) per cent of the cost arrived at on the basis of (a) and (b) above and; d. Applicable taxes. No price adjustment shall apply. The approval for Variation shall state the period of extension of time, if any, allowed for the Variation. If no extension of time is allowed, the same shall be stated."
Sub-Clause 13.7 Adjustments for Changes in Legislation	**Delete first paragraph of the Sub-Clause and Substitute with the following**: "The Contract Price shall be adjusted to take account of any increase or decrease in Cost after the Base Date resulting from: a. a change in the Laws of the Country (including the introduction of new Laws and the repeal or modification of existing Laws); or b. in the judicial or official governmental interpretation of such Laws, or c. the commencement of any Indian law which has not entered into effect until the Base Date; or d. any change in the rates of any of the Taxes or royalties on Materials and Services that have a direct effect on the Project which affect the Contractor in the performance of its obligations under the Contract." **Insert at the end of the Sub-Clause:** "If as a result of change in law, interpretation, or rates of taxes or royalties, the Contractor benefits from any reduction

	in costs for the execution of this Contract, save and except as expressly provided for in this Sub-Clause or in accordance with the provisions of this Contract, the Contractor shall, within [28] days from the date he becomes reasonably aware of such reduction in cost, notify the Employer with a copy to the Engineer of such reduction in cost."
Sub-Clause 13.8 Adjustment for Changes in Cost	**Delete Paragraph 3 of this Sub-Clause and Substitute with the following:** "The adjustment to be applied to the amount otherwise payable to the Contractor, as valued in accordance with the appropriate Schedule and certified in Payment Certificates, shall be determined from formulae for each of the currencies in which the Contract Price is payable. No adjustment is to be applied to work valued on the basis of Cost or current prices. The formula for adjustment for changes in cost shall be as follows: (A) <u>For Signalling Works Cost Centre [2.1.2, 2.1.3, 2.1.4, 2.1.5 & 2.1.6], Telecommunication Works Cost Centre [2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.7 & 2.2.8] and Buildings & Structures Works Cost Centre [2.3.1]</u> The formula for adjustment for changes in cost shall be as follows: Pn = a + b(Ln/Lo) + c(Fn/Fo) + d(Mn/Mo) where: "Pn" is the adjustment multiplier to be applied to the contract amount paid against cost center / stage as per Price Schedule in the relevant currency for the completed stage of work; "**a**" is a fixed coefficient, representing the **non-adjustable portion** for various cost center as per price schedule; "**b**" is a fixed coefficient, representing the adjustable portion for **Labour** component for various cost center as per price schedule; "**c**" is a fixed coefficient, representing the adjustable portion for **Fuel & Power** for relevant cost center as per price schedule; "**d**" is a fixed coefficient, representing the adjustable portion for **Material** for relevant cost center as per price schedule; Values of a, b, c and d for various cost centers are detailed

	in Annexure I of the Appendix to Tender "Ln", "Fn" and "Mn" are the current cost indices or reference prices for period "n", expressed in the relevant currency of payment, each of which is applicable to the relevant tabulated cost element on the date 49 days prior to the last day of the period, (to which the particular Payment Certificate relates) as detailed in the Annexure I to Appendix to tender. "Lo", "Fo" and "Mo" are the base cost indices or reference prices, expressed in the relevant currency of payment, each of which is applicable to the relevant tabulated cost element on the Base Date, as detailed in the Annexure I to Appendix to tender."
Sub-Clause 14.1 Contract Price	**Add the following after the last paragraph -** "The Contract Price includes all duties, taxes, royalties, premiums for various insurances, licenses and fees that may be levied in accordance with the laws and regulations in force as on the Base Date on the Contractor's Equipment, Plant, Materials and supplies acquired for the purpose of the Contract and on the services performed under the Contract. Nothing in the Contract shall relieve the Contractor from its responsibility to pay any tax including any tax that may be levied in India on profits made by it in respect of the Contract."
Sub-Clause 14.3 Application for Interim Payment Certificates	**Delete first paragraph of this Sub-Clause and substitute with the following:** "The Contractor shall submit a Statement in six paper copies and two digital copies (Read Only CD/DVD) to the Engineer after the end of the period of payment stated in the Contract (if not stated, after the end of each month), in a form approved by the Engineer, showing in detail the amounts to which the Contractor considers himself to be entitled, together with supporting documents and shall include the relevant report on progress also in accordance with Sub-Clause 4.21 [*Progress Report*], in two paper copies & two digital copies (Read Only CD/DVD). All paper copies shall bear the original signatures of the Contractor. If these are found in order then the Engineer shall forward the same to the Employer, with Interim Payment Certificate, as per clause

	14.6, for payment, otherwise return back all documents to the Contractor for rectification and resubmission. Responsibility of preferring the Statement and entering the details shall vest with the Contractor. It is his responsibility to ensure that under no circumstances the payment claimed is more than the amount equivalent of Work done for that stage. If it is discovered otherwise during the check by the Engineer or the Employer then a warning will be issued in the first instance and in the second instance amount equivalent to 10% of excess claimed shall be forfeited besides denying the extra claim. While submitting the Statement all supporting details like measurements, sketches, drawings, approvals, calculations etc. shall be submitted with the Statement so that payment can be substantiated by the Engineer as well as by the Employer. Even if no stage of work is completed during the month or Contractor does not choose to submit a Statement, a 'NIL' Statement shall be submitted by him." **In the third line of paragraph 2 (a), delete the word "(g)" and substitute with "(h)"** **Add the following paragraph at the end of this Sub-Clause:** "(h) any amount to be deducted for taxes/ cess in accordance with the applicable laws."
Sub-Clause 14.4 Schedule of Payments	**Delete this Sub-Clause and substitute with the following:** "The Employer shall make interim payments to the Contractor as certified by the Engineer under Sub-Clause 14.6 on the basis of the estimated value of the Works executed as determined in accordance with the following procedure: (a) The Price Schedules 1.0, 2.0, 2.1, 2.1.1 to 2.1.8, 2.2, 2.2.1 to 2.2.9, 2.3 and 2.3.1 lay down the frame work for estimating the value of stages of work completed. The Price Schedules specify the Contract Price for the Works offered by the Contractor and accepted by the Employer, along with the estimated value of work of different cost centres. The description of items of work in the Schedules does not limit in any way the

	Contractor's obligations under the Contract to provide all the Works described in the Employer's Requirements. (b) The entire Works have been primarily divided into three (3) cost centres along with their respective weightage percentages of the Contract Price in Schedule 2.1 (Signalling Works), 2.2 (Telecommunication Works) and 2.3 (Buildings and Structures Works). Each of the cost centres have been further broken into items of works with percentage weightage of the Contract Price to items of the works/stages as indicated in Schedules 2.1.1 to 2.1.8, 2.2.1 to 2.2.9 and 2.3.1. (c) The Bidder shall compute, and supply to the Engineer, the total quantities (in units as described in the Price Schedule-2.1, 2.2 and 2.3) of various items of works and components on the basis of detailed design reviewed/approved by the Engineer. (d) The Contractor shall base its claim for interim payment for each stage for various items of the work on completion till the end of the month for which the payment is claimed, supported with documents and an up-dated programme in accordance with the Employer's Requirements. (e) The weightage/percentage assigned to cost centre will apply only to the Contract Price stated in the Contract Agreement. It shall not apply to any additions or subtractions to the Contract Price arising from the issue of any Variation Orders. Each Variation Order shall specify the manner of interim payments and completion of stages for it. (f) For items of unchartered utilities, extra payment over and above the Contract Price shall be made in accordance with variation proposals made on case to case basis as per the provisions of Contract. Contractor shall make a detailed report/ proposal for removal/ relocation of unchartered utilities as per the procedure outlined in Part 2 "Employer's Requirement, Section VI, Volume 1, General Specification."
Sub-Clause 14.6	**In the 1st Paragraph, 2nd line, '28' is replaced with '15'.**

Issue of Interim Payment Certificates	
Sub-Clause 14.7 Payments	**In the Sub Clause 14.7(b), 1st line, '56' is replaced with '30'.** **Delete the last paragraph of Sub-Clause 14.7 and substitute with the following:** "Payment of the amount due in each currency shall be made in to the bank account of the Contractor (Sole/JV/JVA) or its individually authorised member(s), nominated by the Contractor in the payment country (for this currency) specified in the Contract. However, in respect of foreign currency payments, copies of supporting documents evidencing the import of goods /services shall be submitted by the Contractor. "
Sub-Clause 14.9 Payment of Retention Money	**Delete first para of Sub-Clause 14.9 and substitute with the following:** "A retention amounting to 10 (ten) per cent of the value of the work done shall be deducted by the Engineer in the first and following Interim Payment Certificates, until the amount so retained reaches a limit of retention money of 5 (five) percent of the Contract Price. When the retention money with the Employer has reached 60% of the limit of retention money, the Contractor may, at his option, replace 50% of limit of retention money with an unconditional Bank Guarantee from the Bank, and valid for the period up to the end of the Defect Notification Period. After the issue of taking over certificate for the complete works, the balance amount of Retention Money can also be replaced with an unconditional Bank Guarantee from the Bank and valid for the period up to the end of Defect Notification Period."
Sub-Clause 15.2 Termination by Employer	**Delete the words "the whole" in Sub-Clause (d) and Substitute with the following words** "more than the percentage specified in Sub-Clause 4.4**"**
Sub-Clause 15.3 Valuation at Date of Termination	**Delete the last line of this Sub-Clause "work executed …. Contract" and substitute with the following:** "Work completed up to any defined stage of payment in accordance with the Contract. Extent of damages to the

	Employer due to termination under sub-Clause 15.2 has been fixed as (1) Forfeiture of Performance Security (2) Forfeiture of Retention money (3) five per cent (5%) of the cost of the balance work at the date of termination. The Parties hereby agree that the rate of these damages agreed in this is a reasonable pre-determined amount, and that these damages are not by way of penalty."
Sub-Clause 15.4 Payment after Termination	**Delete the Sub-Clause 15.4 and substitute with the following:** "After a notice of termination under Sub-Clause 15.2 *[Termination by Employer]* has taken effect, the Employer may: (a) proceed in accordance with Sub-Clause 2.5 *[Employer's Claims];* (b) withhold further payments to the Contractor until the actions in accordance with the following sub-paragraphs (c), and (d) are completed; (c) encash and forfeit the whole of the amounts of Performance Security and Retention Money and take possession of Plant and Materials delivered to Site, for which payment has been made by the Employer; (d) encash and appropriate the bank guarantee for the Advance Payment to recover the outstanding amount, if any, of the Advance Payment; and (e) pay to the Contractor any sums due under Sub-Clause 15.3 [Valuation at Termination], after the full amounts of the Performance Security and Retention Money and five per cent (5%) of the cost of the balance work (as per clause 15.3) and any other amount due from the Contractor have been received by the Employer. Any outstanding amounts against the Contractor shall immediately become due and payable by the Contractor to the Employer."
Sub-Clause 16.2 Termination by the Contractor	**Delete the Sub-Clause 16.2 (d)** **Delete the following words from 16.2 (e)** " or Sub-Clause 1.7 [Assignment]"
Sub-Clause 17.3	**Sub-paragraph (h) - Delete**

Employer's Risks	
Sub-Clause 18.1 General Requirement of Insurance	**Delete Sub-paragraph 6(b) and replace with the following** " (b) copies of the policies for the insurances described in (i) Sub-Clause 18.2 [Insurance for Works and Contractor's Equipment], (ii) Sub-Clause 18.3 [Insurance against Injury to Person and Damage to Property], and (iii) Sub-Clause 18.5 [Professional Indemnity Insurance]"
Sub-Clause 18.2 Insurance of Works and Contractor's Equipment	**Sub-paragraph 4 (d) Delete** the words "(c), (g) and (h)", and substitute with the words "(c) and (g)".
Sub-Clause 18.3 Insurance Against Injury to Persons and Damage to Property	**Add the following at the end of this Sub-Clause:** "The insurance policy shall include a cross liability clause such that the insurance shall apply to the Employer, the Contractor and his Subcontractors (wherever applicable) as separately insured. The Employer shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or of any of his Sub- Contractor(s) (wherever applicable), other than death or injury resulting from any act or default of the Employer, his agents or employees. The Contractor shall indemnify and keep indemnified the Employer against all such damages and compensation, other than those for which the Employer is liable as aforesaid, and against all claims, proceedings, damages, costs, charges, and expenses whatsoever in respect thereof or in relation thereto."
Sub-Clause 18.4 Insurance for Contractor's Personnel	**Add the following at the end of this Sub-Clause:** "The Employer shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or any Sub-Contractor (wherever applicable), other than death or injury resulting from any act or default of the Employer, his agents or employees. The Contractor shall indemnify and keep indemnified the Employer against all such damages and compensation, other than those for which the Employer is liable as aforesaid, and against all claims, proceedings,

	damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto."
Sub-Clause 18.5 Professional Indemnity Insurance	**Add the following new Sub-Clause:** "The Contractor shall obtain the professional indemnity insurance, to cover the risk of professional negligence in the design of the Works carried by him, for the amount(s) stated in the Appendix to Tender and the insurance shall be maintained in full force and effect from the Commencement Date of the Works until 03 (three) years after the expiry of the Defects Notification /Extended Defects Notification Period. The insurance policy is required to indemnify the Employer as joint insured and the cover shall apply separately to each insured as though a separate policy had been issued for each of the joint insured. The Engineer will not certify any Payment Certificate until the Contractor has provided evidence of this insurance and its period of effectiveness."
Sub Clause 20.6 **Arbitration**	**Delete Sub-Clause 20.6 and substitute with the following:** "Any dispute not settled amicably and in respect of which the DAB's decision (if any) has not become final and binding shall be finally settled by arbitration. Unless otherwise agreed by both parties, arbitration shall be conducted as follows: (a) For contract with foreign contractors (i) International arbitration in accordance with the rules of arbitration of the International Chamber of Commerce. (ii) The seat of arbitration shall be Singapore/Dubai. (iii) The number of Arbitrators shall be three (3) and language of communication will be English. (b) For contract with domestic contractors (For the purpose of this Sub-Clause, the term "Domestic Contractor" means a Contractor who is registered in India and is juridical person created under Indian Law as well as a joint venture between an Indian partner and a foreign partner where Indian partner is authorized representative of the JV or Lead Member). (i) In accordance with rules of Arbitration of the International Centre for Alternative Dispute Resolution,

	New Delhi or such other rule as may be mutually agreed by the parties and shall be subject to the provision Indian Arbitration and Conciliation Act, 1996 (ii) The seat of arbitration shall be New Delhi. (iii) The number of Arbitrators shall be three (3) and language of communication will be English. The arbitrator(s) shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Engineer, and any decision of the DAB, relevant to the dispute. Nothing shall disqualify the Engineer from being called as a witness and giving evidence before the arbitrator(s) on any matter whatsoever relevant to the dispute. Neither Party shall be limited in the proceedings before the arbitrator(s) to the evidence nor in arguments previously put before the DAB to obtain its decision, or to the reasons for dissatisfaction given in its notice of dissatisfaction. Any decision of the DAB shall be admissible in evidence in the arbitration. Arbitration may be commenced prior to or after completion of the works. The obligations of the Parties the Engineer and the DAB shall not be altered by reason of any arbitration being conducted during the progress of the Works."

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APPENDIX TO TENDER

Item	GC Sub-Clause	Data
Employer	1.1.2.2 & 1.3 (b)	Dedicated Freight Corridor Corporation of India Limited, 5th Floor Pragati Maidan, Metro Station Building Complex, New Delhi, India – 110001 **Authorised Representative and its communication address:** *[To be inserted at the time of signing the Contract]*
Contractor	1.1.2.3 & 1.3 (b)	*[To be inserted at the time of signing the Contract]*
Engineer	1.1.2.4 & 1.3 (b)	*[To be inserted at the time of signing the Contract]*
Time for Completion	1.1.3.3	The Contractor shall complete the whole of the Works within 1000 (One Thousand) days from the Commencement Date and each of the Milestones shall be achieved as per Sub-clause 8.2 of the Particular Conditions of Contract.
Defects Notification Period	1.1.3.7	2 (Two) years
Electronic Communications	1.3 (a)	In case of communication is through fax or e-mails, it should be confirmed through hard copy (paper) within 48 hours of transmission of fax or email. In case of delayed confirmation, the date and time of confirmation shall be deemed to be the date and time of hard copy (paper) communication delivered.
Governing Law	1.4	Republic of India
Ruling Language	1.4	English
Bank	1.15	The International Bank for Reconstruction and Development (IBRD) [World Bank]
Right of Access to the Site	2.1	The Employer / Engineer shall give Right to Access to Site to the Contractor, subject to the

Item	**GC Sub-Clause**	**Data**	
		Contractor providing Performance Security in terms of Sub-Clause 4.2 of General Conditions of Contract, in the following manner: Possession of Site will be handed-over to the Contractor as per the approved Work Plan taking into consideration the progress of the Civil Works Contract Packages (CP 201 & 202) and Electrical Works Contract Package (CP 204) already under execution at the Site of Work.	
Amount of Performance Security	4.2	5 (Five) per cent of the Accepted Contract Amount, in local currency.	
General Design Obligations	5.1	56 Days	
Normal working hours	6.5	(Eight) 8 working hours shift in a day and total 48 (Forty eight) working hours in a week.	
Amount of Delay Damages	8.7 & 14.15 (b)	Milestone	Amount of Delay Damages
		For Milestone-1	₹ 2,00,000/- (INR Rupees Two Lakh) per day
		For Milestone-2	₹ 3,00,000/- (INR Rupees Three Lakh) per day
		For Milestone-3	₹ 4,00,000/- (INR Rupees Four Lakh) per day
		For Milestone-4	₹ 6,00,000/- (INR Rupees Six Lakh) per day
Limit of Delay Damages for the whole of the Works	8.7	5 (Five) per cent of the Accepted Contract Amount in Local currency.	
Provisional Sum	13.5	No Provisional Sum is payable under this Contract.	
Price Adjustment	13.8	As detailed in Annexure I below.	
Advance Payment	14.2	**Mobilization Advance** The Employer shall pay, on written request from the Contractor, an interest free Mobilization Advance up to (Ten) **10** per cent of the Contract	

Item	GC Sub-Clause	Data
		Price. The Mobilization Advance shall be released in two instalments as under: (a) **Up to (Five) 5 per cent:** On Submission of Performance Security and commencement of mobilization process; and (b) **Up to (Five) 5 per cent:** On Submission of the Inception Report and details of utilisation of initial Mobilization Advance of 5% to the satisfaction of Engineer. The Advance Payment will be released on submission of unconditional Bank Guarantee for an amount equivalent to the component of the advance payment requested by the Contractor. Such Bank Guarantees can be split into a maximum of 5 (Five) Bank Guarantees for each of 5% mobilisation advance (at the option of the Contractor) to be released on repayments. All such Bank Guarantee(s) shall remain effective until the advance payment has been repaid pursuant to the provisions of Sub-Clause 14.2 of the Conditions of Contract, but the amount thereof shall be progressively reduced by the amount repaid by the Contractor as indicated in Interim Payment Certificates issued in accordance with this Clause.
Percentage of Retention	14.3 (c)	10 (Ten) per cent
Limit of Retention Money	14.3 (c)	5 (Five) per cent of the Contract Price,
Plant and Materials for payment when delivered to Site	14.5 (c) (i)	For all the Goods / Material for which payment event/stage on Supply/Delivery has been specified in the Price Schedules
Delayed Payment	14.8	The financing charges shall be calculated (i) at an annual rate of LIBOR rate +2% for foreign currency; and (ii) 8% (fixed) for Indian currency

<table>
<tr><th>Item</th><th>GC Sub-Clause</th><th>Data</th></tr>
<tr><td>Currencies of Payment[1]</td><td>14.15</td><td>
<table>
<tr><th>Currencies unit</th><th>Percentage Payable in the Currency</th><th>Rate of exchange: number of Local per unit of Foreign</th></tr>
<tr><td>Local: (INR)</td><td></td><td>1.000</td></tr>
<tr><td>Foreign: [name]</td><td></td><td></td></tr>
<tr><td>[name]</td><td></td><td></td></tr>
<tr><td>[name]</td><td></td><td></td></tr>
</table>
Note: the above table is to be filled before the signing of the Contract Agreement.
</td></tr>
<tr><td>Evidence of Insurance</td><td>18.1 , 18.5</td><td>Before Commencement Date of Works</td></tr>
<tr><td>Relevant Policies</td><td>18.1(b)</td><td>Within 84 days of Commencement Date of Works</td></tr>
<tr><td>Minimum amount of deductibles for insurance of the Employer’s Risk</td><td>18.2 (d)</td><td>Zero Deductible</td></tr>
<tr><td>Minimum amount of third party Insurance</td><td>18.3</td><td>Rs 100,000,000 (One hundred million) for any one occurrence.</td></tr>
<tr><td>Professional Indemnity Insurance</td><td>18.5</td><td>Rs 250,000,000 (Two hundred fifty million)</td></tr>
<tr><td>Appointment of Dispute Adjudication Board</td><td>20.2</td><td>The DAB shall comprise of three members</td></tr>
<tr><td>Failure to Agree Dispute Adjudication Board</td><td>20.3</td><td>Appointing Entity: Chairman of the Institution of Engineers (India) Delhi State Center</td></tr>
</table>

[1] To be filled at the time of signing the Contract

Annexure – I

Price Adjustment

(Sub-Clause 13.8)

1. Values of a, b, c and d for various Cost centres shall be as below:

COST CENTER		**Signalling and Telecommunication**
PRICE SCHEDULE		For Signalling Works Cost Centre [2.1.1 to 2.1.8], Telecommunication Works Cost Centre [2.2.1 to 2.2.9] and Buildings & Structures Works Cost Centre [2.3.1].
COEFFICIENTS[2]		
Fix Component	a	0.15
Labour	b	0.30
Fuel & Power	c	0.15
Material	d	0.40

2. Values for Current Cost indices ("Ln", “Fn” and “Mn) and Base Cost indices ("Lo", "Fo" and "Mo shall be taken as follows:

Item	**Indices**	**If procured from Employer’s Country**	**If procured from outside Employer’s Country**
Labour	Ln or Lo	‘Consumer Price Index for Industrial Workers’ published by Labour Bureau (Government of India)	Index provided by the Bidder in Price Schedule 1 (Part 1 :Section IV Bidding Forms)
Fuel & Power	Fn or Fo	‘Wholesale price index for Fuel & Power’ Code- ‘1200000000’ published by Ministry of Commerce and Industry (Government of India)	
Material	Mn or Mo	‘Wholesale price index for All Commodities’ Code- ‘1000000000’ published by Ministry of Commerce and Industry (Government of India)	

[2] To be filled after finalisation of the cost estimate.

Note: *Currently the indices published by Ministry of Commerce and Industry (Government of India) are available at web-site http://www.eaindustry.nic.in*.

3. Price Adjustment for each cost centre shall be made separately.

4. Price adjustment shall be applied on completion of the specified stage of the item of work tabulated in each Price Schedule.

5. Price adjustment shall be applicable as per following details:

Price Schedule No.	**Heading of Price Schedule**	**Price adjustment pursuant to Sub-Clause 13.8 of Conditions of Contract**
2.1.1	Design & Documentation	Price Adjustment shall not be applicable
2.1.2	Signalling Works at 7 Crossing Stations	Price Adjustment shall be applicable
2.1.3	Signalling Works at 5 Junctions Station s	Price Adjustment shall be applicable
2.1.4	Signalling Works in Automatic Block Sections	Price Adjustment shall be applicable
2.1.5	Train Management System (TMS)	Price Adjustment shall be applicable
2.1.6	Supply of Contract Spares and Special Tools & Test Equipment	Price Adjustment shall be applicable
2.1.7	Integrated Testing & Commissioning and Final Taking Over	Price Adjustment shall not be applicable
2.1.8	Training	Price Adjustment shall not be applicable
2.2.1	Design and Documentation	Price Adjustment shall not be applicable
2.2.2	Telecom Works at 7 Crossing stations	Price Adjustment shall be applicable
2.2.3	Telecom Works at 5 Junction stations	Price Adjustment shall be applicable
2.2.4	Telecom works at Operational Control Centre (OCC)	Price Adjustment shall be applicable
2.2.5	Telecom works in Automatic Block Sections & Single Line Sections	Price Adjustment shall be applicable
2.2.6	Integrated Testing & Commissioning and Final Take-Over	Price Adjustment shall not be applicable
2.2.7	Contract Spares	Price Adjustment shall be applicable

Price Schedule No.	Heading of Price Schedule	Price adjustment pursuant to Sub-Clause 13.8 of Conditions of Contract
2.2.8	Special Tools & Test Equipment	Price Adjustment shall be applicable
2.2.9	Training	Price Adjustment shall not be applicable
2.3.1	Buildings & Structures Works	Price Adjustment shall be applicable

Table of Forms

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LETTER OF ACCEPTANCE

(Sub-Clause 1.1.1.3)

[On the letterhead paper of the Employer]

No. ……
Dated.……

To: *[name and address of the Contractor]*

This is to notify you that your Bid dated *[date]* for execution of the *[name of the Contract and identification number, as given in the Contract Data]* for the Accepted Contract Amount *[amount in numbers and words] [name of currency/currencies]*, as corrected and modified in accordance with the Instructions to Bidders, is hereby accepted by the Competent Authority

You are requested to furnish the Performance Security within 28 days in accordance with the Conditions of Contract, using for that purpose Performance Security Form included in Section IX, Contract Forms, of the Bidding Documents.

Authorized Signature: _____
Name and Title of Signatory: _____
Name of Agency: Dedicated Freight Corridor Corporation of India Ltd

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

Form of

Contract Agreement

THIS AGREEMENT made the _____ day of _____, _____,

BETWEEN

(1) Dedicated Freight Corridor Corporation of India Limited, incorporated under the laws of India and having its principal place of business at 5th Floor, Pragati Maidan Metro Station Building Complex, New Delhi, India – 110001 (hereinafter called **'the Employer'**) of the first part

AND

(2)M/S _____
a company/corporation/JV incorporated under the laws of _____having its principal place of business at _____ (hereinafter called "**the Contractor**") of the other part.

WHEREAS the Employer desires that the Works known as ***"Design, , Supply, Construction, Testing and Commissioning of Signalling, Telecommunication and associated Works of Double Track Railway Lines Under Construction on a Design Build Lump Sum Basis for Mughalsarai - New Bhaupur Section of Eastern Dedicated Freight Corridor-Contract Package No. 203"***should be executed by the Contractor, and has accepted a Bid submitted by the Contractor for the execution and completion of these Works and the remedying of any defects therein,

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement.
   (i) The Letter of Acceptance dated _____;
   (ii) Certificate regarding Authenticity of Document;
   (iii) Minutes of meeting of pre-award clarifications / negotiations after opening of the Second Stage Bid, if any;
   (iv) Addenda to Bidding Documents No. _____ dated _____, *(insert the addenda numbers and date)* if any;
   (v) Letter of Bid-(Two Stage Bidding, Second Stage Bidding) dated _____;

(vi) Appendix to Bid (Percentage Breakup of Lump Sum Bid Price for local & foreign currencies;

(vii) Price Schedules submitted by the Contractor;

(viii) Letter of Bid (First Stage Bidding) dated _____;

(ix) Appendix to Tender;

(x) Particular Conditions;

(xi) General Conditions;

(xii) Memorandum titled 'Changes Required Pursuant to First Stage Evaluation';

(xiii) Employer's Requirements;

(xiv) Contractor's Updated Technical Proposal;

(xv) Part 4 of Bidding document; and

(xvi) Any other documents forming part of the Employer's requirements and Bidding documents.

3. In consideration of the payments to be made by the Employer to the Contractor as indicated in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

5. The **Commencement Date of the Works is** _____*[insert here date of commencement]* as notified by the Engineer vide his letter no. _____ dated_____ and **the Completion date** for Whole of the Works pursuant to Sub-Clause 8.2 of the Conditions of Contract **is** _____*[insert date of Completion]*.

6. **The address of the Employer for notice purposes, pursuant to GC 1.3 is**:

Authorised Representative

[To be inserted at the time of signing the Contract]

with a copy endorsed to the *[To be inserted at the time of signing the Contract]*

7. **The address of the Contractor for notice purposes, pursuant to GC 1.3 is:**

_____

_____*(insert address of the Contractor).*

8. **The address of the Engineer for notice purposes, pursuant to GC 1.3 is:**

_____

_____*(insert address of the Engineer).*

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of Republic of India on the day, month and year indicated above.

Contractor	**Employer**
Signature of the Authorised Person	Signature of the Authorised Person
Name:	Name:
Designation:	Designation:
For and on behalf of M/s _____ _____	For and on behalf of Dedicated Freight Corridor Corporation of India Ltd
Witness-1:	**Witness-1:**
Signature	Signature
Name:	Name:
Designation:	Designation:
Address:	Address:
Witness-2:	**Witness-2:**
Signature	Signature
Name:	Name:
Designation:	Designation:
Address:	Address:

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Performance Security

(Demand Guarantee)

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[insert name and Address of* Employer*]*

Date: _ *[Insert date of issue]*

PERFORMANCE GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _ *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Applicant") has entered into Contract No. *[insert reference number of the contract]* dated *[insert date]*with the Beneficiary, for the execution of _ *[insert name of contract and brief description of* Works*]*(hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of*[insert amount in figures]*()*[insert amount in words]*,[1] such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for your demand or the sum specified therein.

This guarantee shall expire, no later than the …. Day of ……, 2… [2], and any demand for payment under it must be received by us at this office indicated above on or before that date.

---

[1] *The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount specified in the Letter of Acceptance, less provisional sums, if any, and denominated either in the currency(cies) of the Contract or a freely convertible currency acceptable to the Beneficiary.*

[2] *Insert the date twenty-eight days after the expected completion date as described in GC Clause 11.9. The Employer should note that in the event of an extension of this date for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing*

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

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this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."

Advance Payment Security

Demand Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[Insert name and Address of* Employer*]*

Date: *[Insert date of issue]*

ADVANCE PAYMENT GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Applicant") has entered into Contract No. *[insert reference number of the contract]* dated *[insert date]* with the Beneficiary, for the execution of *[insert name of contract and brief description of* Works*]* (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, an advance payment in the sum *[insert amount in figures]* () *[insert amount in words]* is to be made against an advance payment guarantee.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of (*[insert amount in figures]*) *[insert amount in words]*[1] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the Applicant:

(a) has used the advance payment for purposes other than the costs of mobilization in respect of the Works; or

(b) has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to

[1] *The Guarantor shall insert an amount representing the amount of the advance payment and denominated either in the currency(ies) of the advance payment as specified in the Contract, or in a freely convertible currency acceptable to the Employer.*

above has been credited to the Applicant on its account number *[insert number]* at *[insert name and address of Applicant's bank]*..

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Applicant as specified in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that ninety (90) percent of the Accepted Contract Amount, less provisional sums, has been certified for payment, or on the *[insert day]*day of *[insert month]*, 2*[insert year]*,[2] whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____
[signature(s)]

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[2] *Insert the expected expiration date of the Time for Completion. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

Retention Money Security

Demand Guarantee

_____ *[Bank's Name, and Address of Issuing Branch or Office]*

Beneficiary: _____ *[Name and Address of* Employer*]*

Date: _____

RETENTION MONEY GUARANTEE No.: _____

We have been informed that *[name of Contractor]* (hereinafter called "the Contractor") has entered into Contract No. *[reference number of the contract]*dated *[date]*with you, for the execution of *[name of contract and brief description of* Works*]*(hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, when the Taking-Over Certificate has been issued for the Works and the first half of the Retention Money has been certified for payment, payment of *[insert* the second half of the Retention Money *or if the amount guaranteed under the Performance Guarantee when the Taking-Over Certificate is issued is less than half of the Retention Money,* the difference between half of the Retention Money and the amount guaranteed under the Performance Security*]* is to be made against a Retention Money guarantee.

At the request of the Contractor, we *[name of Bank]*hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of (*[amount in figures]*)*[amount in words]*[1] upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation under the Contract because the Contractor used the advance payment for purposes other than the costs of mobilization in respect of the Works.

It is a condition for any claim and payment under this guarantee to be made that the payment of the second half of the Retention Money referred to above must have been received by the Contractor on its account number _____ at *[name and address of Bank]*.

This guarantee shall expire, at the latest, 21 days after the date when the Employer has received a copy of the Performance Certificate issued by the Engineer. Consequently, any

[1] *The Guarantor shall insert an amount representing the amount of the second half of the Retention Money or or if the amount guaranteed under the Performance Guarantee when the Taking-Over Certificate is issued is less than half of the Retention Money, the difference between half of the Retention Money and the amount guaranteed under the Performance Security and denominated either in the currency(ies) of the second half of the Retention Money as specified in the Contract, or in a freely convertible currency acceptable to the Employer.*

demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

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