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BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, INSTALLALTION, OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA – NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

SYSTEM WORKS CONTRACT PACKAGE

Issued on: 29.12.2017

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

(Part-1 to 5)

Employer:

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

A GOVERNMENT OF INDIA ENTERPRISE

under

MINISTRY OF RAILWAYS
INDIA

INVITATION FOR BID
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

Our Ref.: Date

To

From
Managing Director,
DFCCIL
5TH Floor, Pragati Maidan Metro Stn.Building
New Delhi-110001.

DESIGN, SUPPLY, CONSTRUCTION, INSTALLALTION, OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGARAND CHIRAILAPATHU STATION(EXCLUDING NEW KARWANDIYA – NEW DURGAUTI SECTION)OF EASTERN DEDICATED FREIGHT CORRIDOR.

This Bidding process is open for pre-qualified bidders.

The Bid document consists of Five Parts i.e. Technical Bid in Part-1, Part-2, Part-3, & Part-4 and Financial Bid – (Part-5). The contents of these Parts are as under:

TECHNICAL BID:

PART 1 – Bidding Procedures

Section I. Instructions to Bidders
Section II. Bid Data Sheet
Section III. Evaluation and Qualification Criteria (Following Prequalification)
Section IV. Bidding Forms

PART 2 – Employer's Requirements

Section V (A): General Specifications

Volume 1: Scope of Works
Volume 2: General
Volume 3: Design Procedures and Processes
Volume 4: Design Criteria and Specifications
Volume 5: Manufacturing, Supply, Installation, Testing and Commissioning
Volume 6: Appendices

Section V (B): Particular Specifications

Volume 7: Particular Specifications for Signalling works
Volume 8: Particular Specifications for Telecommunication works
Volume 9: Particular Specifications for Electrical works

PART 3 – Conditions of Contract and Contract Forms

Section VI. General Conditions of Contract (GCC) as per FIDIC Yellow Book 1999 - Edition
Section VII. Particular Conditions of Contract (PCC)
Section VIII. Contract Forms

PART 4 – Reference Documents

1. SITE DATA:

a. Formation Alignment(plan & profile)
b. Yard plans

2. Tentative Layout for construction of Transmission Network over EDFC

FINANCIAL BID :

PART – 5 - Price Schedules (To be submitted separately)

1. Preamble
2. PRICE PROPOSAL SUBMISSION SHEET (BDF-10)
3. Schedule – A (Form for Lump sum cost of the Bid) with Annexure-I & II
4. Schedule – B (Form for Apportionment of contract Price for Payments of Electrical, Signal & Telecommunication Works)
5. Schedule –C (Form for Apportionment of contract Price for Payments of Electrical Works according to Cost Centers/ cost sub- centers)
6. Schedule –D (Form for Apportionment of contract Price for Payments of Signaling Works according to Cost Centers/ cost sub- centers)
7. Schedule –E Form for (Apportionment of contract Price for Payments of Telecommunication Works according to Cost Centers/ cost sub -centers)
8. Schedule F – Form for (Apportionment of contract Price for Payments of Building & Structure Works according to Cost centres/cost sub-centers)

Note: *Tenders duly filled in must be submitted at the place by the time and date as specified in the tender notice. Late or delayed tenders shall not be accepted.*

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TECHNICAL BID

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Bidding Procedures

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Section 1: 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 BDS, issues this Bidding Document for "Design, Supply, Construction, Installation, of 2x25 kv Electrification, Signalling & Telecommunication and associated works including Testing and commissioning for double track electrified Railway line on Design Build Lump sum basis from Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya – New Durgauti section) of Eastern** Dedicated Freight Corridor" and as specified in Section V Employer's requirement.

1.2 Throughout these Bidding Documents:

a. The term "in writing" means communicated in written form and delivered against receipt:

b. Except where the context require otherwise, words indicating the singular also include the plural and words indicating the plural also include the singular; and

c. "Day" means calendar day.

1.3 Besides the information given in the Invitation for Bids, following further information are as under:

a. **Date of commencement of Works** – within **42 days** from the date of receipt of "Letter of Acceptance" or as indicated in the 'Letter of Acceptance'.

b. **Period of completion** – 24 months from the date of commencement.

c. **Defect Liabilities Periods** – Defect Notification Period shall be 24 months from the date of taking over of the Works (Sub-Clause-10.1 of GCC) and issue of taking over certifícate by the Engineer.

2. Source of Funds

2.1 The required funds will be arranged by the employer.

3. Eligible Bidders

3.1 A Bidder shall be a private, public or Govt. owned legal entity or any combination of them in the form of joint venture (JV) with a formal intent to enter into an agreement or under an existing agreement in the form of a Joint Venture (JV). The bidder must ensure the following:

a. In case of Single Entity**:**

(i) The applicant should be an Indian firm

ii) Submit Power of Attorney authorizing the signatory of the bid to commit the bidder.

b. In case of Joint Venture:

i) Separate identity/name shall be given to the Joint Venture Firm.

ii) Maximum number of partners in the JV shall be limited to 4 (Four).

iii) A member of JV firm shall not be permitted to participate either in individual capacity or as a member of another JV firm in the

same tender.

iv) The *Bid Document* form can be purchased in the name of the Bidder/JV Firm or lead member of JV firm.

v) One of the members of the JV firm shall be its lead member who shall have majority (at least 51%) share of interest in the JV firm. The other members shall have a share of not less than 20% each in case of JV firms with up to 3 members and not less than 10% each in case of JV having more than three members.

vi) In case of JV firm with foreign member(s), the lead member has to be an Indian firm with a minimum share of 51%.

vii) Bidder from a country may be excluded if as a matter of law or official regulations the Government of India (GOI) prohibits commercial relations with the country.

viii) Joint And Several Liability - Members of the JV Firm to which the contract is awarded, shall be jointly and severally liable to the Employer (DFCCIL) for execution of the project in accordance with General and Special Conditions of Contract. The JV members shall also be liable jointly and severally for the loss, damages caused to the DFCCIL during the course of execution of the contract or due to non-execution of the contract or part thereof.

ix) Duration of the Joint Venture Agreement - shall be valid during the entire currency of the contract including the period of extension, if any and the defect liability period after the work is completed.

x) Governing Laws - The Joint Venture Agreement shall in all respect be governed by and interpreted in accordance with Indian Laws.

xi) The JV shall nominate a representative (from lead partner only) who shall have the authority to conduct all business for and on behalf of JV during the bidding process and subsequent stages.

xii) BID SECURITY shall be submitted by JV Firm/Lead member of the JV firm. The BID SECURITY submitted by the Lead member shall be deemed as BID SECURITY submitted by JV Firm.

xiii) A copy of Memorandum of Understanding (MOU) executed by the JV members shall be submitted by the JV Firm along with the Tender. The complete details of the members of the JV firm, their share and responsibility in the JV firm etc. particularly with reference to financial, technical and other obligations shall be furnished in the MOU.

xiv) Once the tender is submitted, the MOU shall not be modified / altered / terminated during the validity of the tender. In case the tenderer fails to observe/comply with this stipulation, the full *Bid Security Deposit (BSD)* shall be liable to be forfeited.

xv) Approval for change of constitution of JV Firm shall be at the sole discretion of the Employer (DFCCIL). The constitution of the JV Firm shall not be allowed to be modified except when modification becomes inevitable due to succession *laws* etc.

and in any case the minimum eligibility criteria should not get vitiated. However, the Lead Member shall continue to be the Lead Member of the JV Firm. Failure to observe this requirement would render the offer invalid.

xvi) Similarly, after, the contract is awarded, the constitution of JV Firm shall not be allowed to be altered during the currency of contract except when modification become inevitable due to succession laws etc. and in any case the minimum eligibility criteria should not get vitiated. Failure to observe this stipulation shall be deemed to be breach of contract with all consequential penal action as per contract conditions.

xvii) On award of contract to a JV Firm, a single Performance Guarantee shall be submitted by the JV Firm as per tender conditions. All the Guarantees like Performance Guarantee, Bank Guarantee for Mobilization Advance, Machinery Advance, etc. shall be accepted only in the name of the JV Firm and no splitting of guarantees amongst the members of the JV *Firm* shall be permitted.

xviii) On issue of LOA (Letter Of Acceptance), an agreement among the members of the JV Firm (to whom the work has been awarded) shall be executed and got registered before the Registrar of the Companies under Companies Act or before the Registrar/Sub-Registrar under the Registration Act, 1908. This JV Agreement shall be submitted by the JV Firm to the DFCCIL before signing the contract agreement for the work. In case the tenderer fails to observe/comply with this stipulation, the full BID SECURITY shall be forfeited and other penal actions due shall be taken against partners of the JV and the JV.

xix) No member of the Joint Venture Firm shall have the right to assign or transfer the interest right or liability in the contract without the *written* consent of the other members and that of the employer (DFCCIL) in respect of the said tender*/contract.*

xx) In case one or more of the members of the JV Firm is/are partnership firm(s), following documents shall be submitted :

(a) Notary certified copy of the Partnership Deed

(b) Consent *of* all the partners to enter into the Joint Venture /Agreement on a stamp paper of appropriate value (in original).

(c) Power of Attorney (duly registered as per prevailing law) in favour of one of the partners of the partnership firm to sign the JV Agreement on behalf of the partnership firm and create liability against the firm.

xxi) In case one or more members is/are Proprietary Firm or HUF, the following documents shall be *enclosed :*

Affidavit on Stamp Paper of appropriate value declaring that his/her Concern is a Proprietary Concern and he/she is sole proprietor of the Concern OR he/she is in position of ''KARTA" of Hindu Undivided Family (HUF) and he/she has the authority, power and consent given by other *partners* to act on behalf of HUF.

xxii) In case one or more members is/are limited companies, the following documents shall be submitted :

(a) Notary certified copy of resolutions of the Directors of the

Company, permitting the company to enter into JV agreement, authorizing MD or one of the Directors or Managers of the Company to sign JV Agreement, such other documents required to be *signed* on behalf of the Company and enter into liability against the company and/or do any other act on behalf of the company.

(b) Copy of Memorandum and Articles of Association of the Company.

(c) Power of Attorney (duly registered as per prevailing law) by the Company authorizing the person to do/act mentioned in the para (a) above.

3.2 A firm that is under a declaration of ineligibility by the Employer in accordance with ITB 35, on the date of the deadline for bid submission or thereafter, shall be disqualified.

3.3 A Bidder shall not have any conflict of interest with any other party involved with the project, either as a bidder or in any other capacity during the project formulation and developmental stage. Any Bidder (s) including all members of JV found to have a conflict of interest shall be disqualified. A Bidder may be considered to be in a conflict of interest with one or more parties in this bidding process, if, including but not limited to:

(a) if they participated as a consultant in the preparation of the design or technical specifications of the Works that are the subject of this Bid.

(b) Where a firm, or a firm from the same economic or financial group, in addition to consulting, also has the capability to manufacture or supply goods or to construct works, that firm, or a firm from the same economic or financial group, cannot normally be a supplier of goods or works, if it provided consulting services for the contract corresponding to this Bid , unless it can be demonstrated that there is not a significant degree of common ownership, influence or control.

3.4 The Bidder shall also be considered disqualified / in- eligible if

(a) The Bidder or any of its partners and/or subcontractors included in the Bid has been banned for business with Ministry of Railways along with any of its attached and subordinate offices through an order issued by Ministry of Railways as per list available on Web site (http://www.indianrailways.gov.in/railwayboard) of Railway Board pertaining to Banning of Business, with the Banning being valid as on the last date of submission the Bid.

(b) The Bidder or any of its partners has suffered bankruptcy / insolvency or it is in the process of winding-up or there is a case of insolvency pending before any Court on the deadline of submission of Bid.

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

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

4. Eligible Materials and

4.1 The materials and equipment to be supplied under the Contract shall be from the approved sources as specified in Part -2 ,**Section V:**

Equipment. **Employer's Requirements.** In addition to above, materials not covered under approved sources specified in **Section V: Employer's Requirements,** should be procured as per the approval of Employer personal.

B. Contents of Bidding Document

5. Sections of Bidding Document The Bid document consists of Five Parts i.e.

Technical Bid in Part-1, Part-2, Part-3, & Part-4 and
Financial Bid – Part-5

The contents of these Parts are as under:

TECHNICAL BID :

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

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Section VI. General Conditions of Contract (GCC) as per FIDIC Yellow Book 1999-Section VII. Special Conditions of Contract (SCC)

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a. Formation Alignment(plan & profile)

b. Yard plans

2. Tentative layout for construction of Transmission Network over EDFC

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PART – 5 - Price Schedules (To be submitted separately)

1. Preamble
2. PRICE PROPOSAL SUBMISSION SHEET (BDF-10)
3. Schedule – A (Form for Lump sum cost of the Bid) with Annexure I & II

4. Schedule – B (Form for Apportionment of contract Price for Payments of Electrical, Signal & Telecommunication Operation Works)
5. Schedule –C (Form for Apportionment of contract Price for Payments of Electrical Works according to Cost Centers/ cost sub- centers)
6. Schedule –D (Form for Apportionment of contract Price for Payments of Signaling Works according to Cost Centers/ cost sub- centers)
7. Schedule –E Form for (Apportionment of contract Price for Payments of Telecommunication Works according to Cost Centers/ cost sub -centers)
8. Schedule F – Form for (Apportionment of contract Price for Payments of Building & Structure Works according to Cost centres/cost sub-centers)

The contents of all these sections listed above shall be read in conjunction with any addenda issued in accordance with **ITB-7.**

5.1 The Invitation for Bids (IFB) issued by the Employer is not part of the Bidding Document.

5.2 A bid can be submitted only on a set of bidding documents obtained directly from the Employer or downloaded from DFCCIL's website. Cost of Bid document shall be as specified in Invitation for Bids (IFB).

5.3 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.

6. Clarification of Bidding Document, Site Visit, Pre-Bid Conference

6.1 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 inquiries during the pre-bid conference in accordance with **ITB 6.4**. The Employer will respond in writing to any request for clarification provided that such request is received 3 days prior to the pre-bid conference. 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 7** and **ITB 19.2**.

6.2 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 construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense.

6.3 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 himself 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.

6.4 The Bidder's designated representative is invited to attend a pre-bid conference, if provided for in the BDS. The purpose of the conference will be to clarify issues and to answer questions related to the subject work that may be raised at that stage.

6.5 The Bidder is requested to submit any questions/queries in writing, to reach the Employer not later than 3 days before the Pre-Bid-

Conference.

6.6 Minutes of the pre-bid meeting, including the text of the questions/queries 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 directly from the Employer. Any modification to the Bidding Document 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/ corrigendum pursuant to **ITB 7** and not through the minutes of the Pre-Bid-Meeting.

6.7 Non-attendance at the pre-bid conference will not be a cause for disqualification of a Bidder.

7. Amendment of Bidding Document

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

7.2 Any addendum issued shall be part of the Bidding Document and shall be communicated in writing to all who have obtained the Bidding Document form the Employer in accordance with ITB 5.2. This will also be uploaded on DFCCIL website **www.dfccil.gov.in.** All prospective Bidders are advised to see the DFCCIL website **www.dfccil.gov.in.** before submitting their bid to check for any amendment/ corrigendum issued in regard to this Bid.

7.3 To give prospective Bidders reasonable time 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**

C. Preparation of Bids

8. Cost of Bidding

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

9. Language of Bid

9.1 The Bid, as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Employer, shall be written in English. 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 pages in English as certified by the Embassy/High Commission/ Consulate of Indian origin of the bidder or the Embassy /High Commission / Consulate of the country of origin of the bidder in India. For the purpose of interpretation and evaluation of the bid, translation certified by Embassy/High Commission/ Consulate shall prevail.

10. Documents Comprising the Bid

10.1 The Bid shall comprise two separate envelopes submitted simultaneously, one containing the **Technical Proposal and the Financial Proposal**, enclosed together in an outer single envelope.

10.2 Initially, only the Technical Proposals will be opened at the address, date and time specified in **ITB Sub-Clause 21.1.** The Financial Proposals remain sealed and are held in custody by the Employer. The Technical Proposals are evaluated by the Employer. No amendments or changes to the Technical Proposals are permitted. Bids with Technical Proposals which do not conform to the specified requirements will be rejected as deficient Bids.

10.3 Financial Proposals of technically compliant Bids will be opened in public at a date and time advised by the Employer. The Financial Proposals are evaluated and the Contract is awarded to the Bidder who's Bid has been determined to be the lowest evaluated substantially responsive Bid.

10.4 The Technical Proposal shall contain the following :

a) Technical Proposal Submission Sheet in accordance with **ITB 14;**

b) Bid Security, in accordance with **ITB Clause 16**;

c) Written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with **ITB Clause 17.2;**

d) Relevant forms as specified for establishing the eligibility criteria of the Bidder in Part -1 Section IV of the Bid document

(e) All the information needed in the eligibility criteria as contained in **Part-1 Section III of the Bid Document**;

(f) Any other document required in the BDS.

10.5 The Financial Proposal shall contain the following :(**to be submitted separately**)

(a) Price Proposal Submission Sheet.

(b) Price Schedule as per the format given in Part-5 Price Schedule of the Bid Document.

(c) Any other document required in the BDS.

11. Bid Submission Sheets and Price Schedules

11.1 The Bidder shall submit the Technical Proposal and the Financial Proposal using the appropriate Submission Sheets furnished in **Section IV (Bidding Forms) of the Bid Document**. These forms must be completed without any alterations to their format, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.

11.2 The Bidder shall submit, as part of the Financial Proposal a Lump-Sum cost for the entire work as per the format given in Schedule A of Part – 5 - Price Schedule of the Bid Document.

12. Bid Prices

12.1 The bidder shall quote the lump sum cost for the entire work in Schedule A as contained in Part -5 of the Bid Document. The cost should cover all the items of the work as detailed in the employer's requirement of the contract. The cost should also be inclusive of all constructional Equipment, plant, labour, supervision, materials, erection, insurance, profit, duties, taxes, levies, royalties together with all general risks, liabilities and obligations set out or implied in the Contract under the applicable law as on the date of opening of bid.

12.2 PVC as given in clause 13.8 of Particular Conditions of Contract will be applicable on the Lump-sum cost of the bid with respect to the base date as defined in the GCC.

13. Currencies of Bid and Payment

13.1 The currency (ies) of the bid and the currency (ies) of the payment shall be, as specified in the BDS,

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

13.3 Payments shall be made as per billing process laid down in Financial Bid Part-5 – Price Schedules of Bidding Document.

14. Documents Comprising the Technical Proposal

14.1 The bidder shall furnish all the information as detailed in Technical Proposal, Section –III Evaluation and Qualification criteria of bidding document.

14.2 The Bidder shall furnish a commitment in Technical Proposal Submission Sheet (BDF-1) for deployment of equipment and personnel as stipulated in Part -1 Section –III, Evaluation and Qualification criteria.

15. Period of Validity of Bids

15.1 Bids shall remain valid for a period of **180** days after the bid submission deadline date prescribed by the employer. A bid valid for a shorter period shall be rejected by the employer as non-responsive.

15.2 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 16**, it shall also be extended Sixty (60) 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.

16. Bid Security

16.1 The Bidder shall furnish as a part of its bid , a Bid Security in favour of DFCCIL, New Delhi in original form as specified in BDS.

16.2 The bid security shall be valid for period up to Ninety (90) days beyond the original validity period of the bid, or sixty (60) days beyond any period of extension if requested under **ITB 15.2** whichever is later.

16.3 Any bid not accompanied by an enforceable and compliant bid security, if one is required in accordance with **ITB 16.1**, shall be rejected by the Employer as non-responsive. The Bid security of unsuccessful bids shall be returned on award of contract.

16.4 The bid security of the successful Bidder shall be dealt as per BDS.

16.5 The bid security may be forfeited:

(a) if a Bidder withdraws its bid during the period of bid validity specified by the Bidder on the Letter of Bids, except as provided in ITB 15.2 or

(b) if a Bidder misrepresents or omits any material the facts in order to unfairly influence the procurement process;

(c) if the successful Bidder fails to:

i) Sign the Contract in accordance with **ITB 34;**

ii) Furnish a performance security in accordance with **ITB 33;**

iii) Accept the correction of its Bid Price pursuant to **ITB 28.2;**

16.6 The Bid Security of a JV shall be as per **ITB 3.1 b(xii).**

17. Format and Signing of Bid

17.1 The Bidder shall prepare one original of the Technical Proposal and one original of the Financial Proposal as described in ITB Clause 10 and clearly mark each “ORIGINAL - TECHNICAL PROPOSAL” and “ORIGINAL - FINANCIAL PROPOSAL”. In addition, the Bidder shall submit 2 copies of the Technical Proposal and clearly mark them “COPY NO… - TECHNICAL PROPOSAL” . In the event of any discrepancy between the original and the copies, the original shall prevail. In addition one soft copy (Read Only) of Technical proposal should also be submitted along with the Bid.

17.2 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 and amendments have been made shall be signed or initialed by the person signing the bid.

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

D. Submission and Opening of Bids

18. Sealing and Marking of Bids

18.1 The Bidder shall enclose the original of the Technical Proposal, the original of the Financial Proposal, and two copies of the Technical Proposal, in separate sealed envelopes, duly marking the envelopes as "ORIGINAL - TECHNICAL PROPOSAL", "ORIGINAL - FINANCIAL PROPOSAL" and "COPY NO… - TECHNICAL PROPOSAL" , as appropriate. These envelopes containing the original and the copies shall then be enclosed in one single envelope. One single envelope containing the envelopes of Technical, Financial bids& Bid security, cost of the Bid document (if document is downloaded) shall be signed and stamped by the authority who has signed the bids otherwise. **Each copy shall be serially numbered, Indexed and hard bound.**

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 BDS;

(c) bear the specific identification (IFP No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN dated 29.06.2017) of this bidding process indicated in the BDS; and

(d) The outer envelopes and the inner envelopes containing the Technical Proposals shall bear a warning not to open before the time and date for the opening of Technical Proposals, in accordance with ITB Sub-Clause 21.

(e) **The inner envelopes containing the Financial Proposals shall bear a warning not to open until advised by the Employer in accordance with ITB Sub-Clause 21.**

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 bid.

18.4 In case Financial Proposal in a bid is received unsealed then the bid shall be considered as non-responsive and will not be dealt with. If, financial proposal is submitted in the technical proposal then also the bid shall be considered as non-responsive and will not be dealt with.

19. Deadline for Submission of Bids

19.1 Bids must be received by the Employer at the address and no later than the date and time indicated in the BDS.

19.2 The Employer may, at its discretion, extend the deadline for the submission of bids by amending the Bidding Document in accordance with **ITB 7**, 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. Late Bids

20.1 The Employer shall not consider any bid that arrives after the deadline for submission of bids, in accordance with **ITB 19**. Any bid received by the Employer after the deadline for submission of bids shall be declared late, rejected, and returned unopened to the Bidder.

21. Bid Opening

21.1 The Employer shall conduct the opening of Technical Proposals in the presence of Bidders' representatives who choose to attend, at the address, date and time specified in the BDS.

21.2 The financial Proposals will remain unopened and will be held in custody of the Employer until the time of opening of the Financial Proposals. The date, time, and location of the opening of Financial Proposals will be advised in writing by the Employer to all the bidders who have been determined qualified in technical evaluation.

21.3 All other envelopes holding the Technical Proposals shall be opened one at a time, and the following read out and recorded :

(a) the name of the Bidder;

(b) whether there is a modification or substitution;

(c) the presence of a Bid Security, if required; and

(d) any other details as the Employer may consider appropriate.

21.4 Only Technical Proposals read out and recorded at bid opening shall be considered for evaluation. No Bid shall be rejected at the opening of Technical Proposals except for late bids, in accordance with **ITB Sub-Clause 20.1.**

21.5 The Employer shall prepare a record of the opening of Technical Proposals that shall include, as a minimum: the name of the Bidder and the presence or absence of a Bid Security. 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.

21.6 At the end of the evaluation of the Technical Proposals, the Employer will invite bidders who have submitted substantially responsive Technical Proposals and who have been determined as being qualified for award to attend the opening of the Financial Proposals. The date, time, and location of the opening of Financial Proposals will be advised in writing by the Employer. Bidders shall be given reasonable notice of the opening of Financial Proposals.

21.7 The Employer shall conduct the opening of Financial Proposals of all Bidders who submitted substantially responsive Technical Proposals and who have been determined qualified as a result of technical evaluation, in the presence of Bidders` representatives who choose to attend at the address, date and time specified by the Employer. The Bidder's representatives who are present shall be requested to sign a register evidencing their attendance.

21.8 All envelopes containing Financial Proposals shall be opened one at a time and the following read out and recorded :

(a) the name of the Bidder

(b) the Bid Price(s), including any discounts

(c) any other details as the Employer may consider appropriate.

21.9 Only Financial Proposals, discounts, read out and recorded during the opening of Financial Proposals shall be considered for evaluation. No Bid shall be rejected at the opening of Financial Proposals.

21.10 The Employer shall prepare a record of the opening of Financial Proposals that shall include, as a minimum: the name of the Bidder, the Bid Price including any discounts. 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.

E. Evaluation and Comparison of Bids

22. Confidentiality

22.1 Information relating to the examination, evaluation & comparison of Bids and recommendation of contract award, 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.

22.2 Any attempt by a Bidder to influence the Employer in the examination, evaluation &comparison of the Bids or Contract award decisions may result in the rejection of its Bid.

22.3 Notwithstanding **ITB Sub-Clause 23.2,** from the time of opening the Technical Proposals 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.

23. Clarification of Bids

23.1 To assist in the examination, evaluation & comparison and pre-qualification of the Bids, 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 Financial Proposals, in accordance with **ITB Clause 28.**

23.2 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.

24. Deviations, Reservation, and Omissions

24.1 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.

25. Determination of Responsiveness

25.1 The Employer's determination of a bid's responsiveness is to be based on the contents of the bid itself, as defined in **ITB 10**.

25.2 A substantially responsive bid is one that meets the requirements of the Bidding Document 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.

25.3 The Employer shall examine the technical aspects of the bid submitted in accordance with **ITB 14**, Technical Proposal, in particular, to confirm that all requirements of Part -1 Section III (Evaluation and Qualification criteria) have been met without any material deviation or reservation, or omission.

25.4 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. The Employer's decision in this connection shall be final and binding

26.Non conformities, Errors, and Omissions

DELETED

27. Evaluation of Technical Bids

27.1 The Employer shall determine to its satisfaction during the evaluation of Technical Proposals whether Bidders are qualified to perform the Contract satisfactorily.

27.2 The determination shall be based upon an examination of the documentary evidence of the Technical Proposal submitted by the Bidder, pursuant to **ITB Clause 14**, to clarifications in accordance with **ITB Clause 23** and the qualification criteria indicated in Part-1 **Section-III**, Evaluation and Qualification Criteria.

27.3 The Employer will carry out a detailed evaluation of the 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;

27.4 An affirmative determination shall be a prerequisite for the opening and evaluation of a Bidder's Financial Proposal. A negative determination shall result into the disqualification of the Bid, in which event the Employer shall return the unopened Financial Proposal to the Bidder.

27.5 if the bidder proposes to engage any subcontractors additional to or different from those named in pre-qualification stage 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.

28. Correction of Arithmetical Errors

28.1 Provided that the bid is substantially responsive, the Employer shall correct arithmetical errors as under:

if there is a discrepancy between words and figures, the amount in words shall prevail.

28.2 If the Bidder that submitted the lowest evaluated bid does not accept the correction of errors, its bid shall be disqualified and its bid security may be forfeited.

29. Evaluation of Financial Bids

29.1 The Employer shall evaluate Financial Proposals of each Bid for which the Technical Proposals have been determined to be substantially responsive as per evaluation criteria given in Part – 1 Section-III, of the Bid Document.

29.2 To evaluate the financial proposal of a bid, the Employer shall consider the following:
i) Total lump sum bid price;
ii) Discounts offered if any.

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.

30. Comparison of Bids

30.1 The Employer shall compare all substantially responsive bids to determinethe lowest evaluated bid, in accordance with **ITB 29**.

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

31.1 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 returned to the Bidders.

F. Award of Contract

32. Notification of Award

32.1 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") and the requirement for the Contractor to remedy any defects therein as prescribed by the Contract.

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

33. Performance Security

33.1 Within Thirty (30) days of the receipt of Letter of Acceptance from the Employer, the successful Bidder shall furnish the performance security in accordance with the conditions of contract, using for that purpose the Performance Security Form included in Part-3, Section VIII: Contract Forms of Bid Document or another form acceptable to the Employer.

33.2 Failure of the successful Bidder to submit the above-mentioned Performance Security or to sign the Contract Agreement shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security.

34. Signing of Contract

34.1 After notification and submission of performance security, the Employer shall send the successful Bidder the Contract Agreement.

34.2 Within Thirty (30) days of receipt of the Contract Agreement, the successful Bidder shall sign, date, and return it to the Employer.

35. Corrupt Practices

35.1 It is the Employer's Policy that bidders, Suppliers, Contractors and their sub-Contractors, observe the highest standard of ethics during the procurement and execution of the contract[1]. In pursuance of this policy, the employer:

(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[2];

(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[3];

(iii) "collusive practice" is an arrangement between two or more parties[4]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[5] 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 an 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 Employer's inspection and audit rights provided for under sub-clause 35.1, (d) below.

(b) will reject a proposal for award if it determines that the Bidder

[1] In this context, any action taken by a Applicant, supplier, contractor, or a sub-contractor to influence the procurement process or contract execution for undue advantage is improper.

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

[3] a "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.

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

[5] a "party" refers to a participant in the procurement process or contract execution.

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 sanction a firm or individual, at any time including by publically declaring such firm or individual ineligible, either indefinitely or for a stated period of time, Employer if it at any time determines that the firm has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing.

(d) Will have the right to get the accounts, records and other documents relating to the bid submission and contract performance or the bidders, suppliers, and contractors and their sub-constructors audited by auditors appointed by the Employer.

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Section II. Bid Data Sheet

A General

B Contents of Bidding Document, Site Visit, Pre-bid Conference

C Preparation of Bids

D Submission and Opening of Bids

Section II: Bid Data Sheet

This section consists of provisions that are specific to each procurement and supplement the information or requirements included in Section I –Instructions to Bidders.

A. General	
ITB 1.1	**The number of the Invitation for Bids is :** Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH & SEBN
ITB 1.1	**The Employer is**: Dedicated Freight Corridor Corporation of India Limited (DFCCIL) , NEW DELHI
ITB 1.1	**The name of the IFP is:** DESIGN, SUPPLY, CONSTRUCTION, INSTALLALTION, OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA – NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.
B. Contents of Bidding Document, Site Visit, Pre-bid conference	
ITB 6.1	All communication between the Employer and the Bidder shall be in writing. For the purposes of seeking clarification, the Employer's address is : **Prior to the award of contract**. Attention: Mr. Suresh Kumar Designation: Group General Manager/S&T-III/EC Address : **Dedicated Freight Corridor Corporation of India Limited** Room # 436(C), 4th Floor, Pragati Maidan Metro Station Building Complex, New Delhi -110001, India. Email: sureshkumar@dfcc.co.in Telephone: (011) 23379850 Facsimile number (011) 23454701
ITB 6.4	**Pre Bid Conference**: A pre-Bid conference will be held to clarify the issues related to this Bid document on the date, time and venue of the Pre Bid conference indicated below. Bidders should give their queries in writing upto 03 days prior to pre-Bid Conference. All interested Bidders may attend the Pre-Bid Conference. DFCC response to queries as well as addenda to bidding document will be posted on the DFCCIL's website. Non-attendance at the pre-Bid conference will not be a cause for disqualification of the Bidder. **Date: 10.01.2018 Time: 11:00 hrs.** Venue: Conference Room, Dedicated Freight Corridor Corporation of India Limited, 4th Floor, Pragati Maidan Metro Station Building Complex, New Delhi-110001. Website of DFCC : www.dfccil.gov.in Site visit is not proposed to be organized by the Employer. However, the bidders are advised to visit the site before pre-bid conference.
C. Preparation of Bids	
ITB 11.2	The prices quoted by the Bidder shall be adjustable in accordance with the provisions in Sub Clause 13.8 of Particular Conditions of Contract.
ITB 13.1	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 in the **Annexure I & II of Schedule A of BDF-10** the percentage (s) of the Bid Price, 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.rbiorg.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. For procurement of Goods and Services from off shore sources applicable whole sale 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 whole sale 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 13.2	Foreign currency requirements shall be indicated only in respect of those Goods and Services which the bidder expects to procure from off shore sources.
ITB 15.1	The bid validity period of bids shall be **180 (One hundred and Eighty only)** days.
ITB 16.1	The bidder should submit along with the bid, a bid security for Rs. 3.74 crore (Rupees Three Crore seventy four lakhs only) in the following form: i) FDR (Fixed Deposit Receipt)/ Demand Draft/ Banker's Cheque/ Pay Order for Rs. 1.00 crore **and** ii) Bank Guarantee as per format enclosed as BDF-9A for Rs. 2.74 crore in favour of "Dedicated Freight Corridor Corporation of India Ltd., New Delhi" from Nationalized/ Indian Scheduled Commercial Bank in original form. **The validity of FDR should not be less than 270 days.**
ITB 16.4	The bid security of the successful Bidder submitted in the form of Bank Guarantee shall be returned on Execution of contract Agreement and submission of Performance Guarantee. However, bid security of the successful Bidder submitted in the form of FDR (Fixed deposit receipt)/ Demand Draft/ Banker's Cheque/ Pay Order for Rs. 1.00 Crore shall be retained as Retention Money and adjusted against the Retention money (reference GCC/PCC sub-clause 14.9).
ITB 17.2	The written confirmation of authorization to sign on behalf of the Bidder shall consist of: In case of Companies • Power of Attorney authorizing the signatory of the bid to commit the bidder In case of Joint Venture • Power of Attorney for Authorized Signatory of Joint Venture.
D. Submission and Opening of Bids:	

ITB 19.1	Tender Box for submission of Bid shall remain open: From **10:00 Hrs to 17:00 Hrs on all working days from 29.01.2018 to 31.01.2018 upto 15:00 Hrs** at the address given below: Office of Group General Manager/S&T-III/EC, Dedicated Freight Corridor Corporation of India Limited Room No. 436 (C), 4th Floor, Pragati Maidan Metro Station Building Complex, New Delhi - 110001, India
ITB 21.1	The Technical bid opening shall take place at: Dedicated Freight Corridor Corporation of India Limited, Conference Hall, 4th Floor ,Pragati Maidan Metro Station Building Complex, New Delhi-110001, India **Technical Bid Opening**: **Date: 31.01.2018 Time: 15:30 hrs.**

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Section III. Evaluation and Qualification Criteria

The purpose of this Section is to establish that the Bidder continues to meet the criteria stipulated in sub clause no. 1 of section III of PQ document 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 25, ITB 27 and ITB 29 and ITB 30 Part 1. The Bidder shall provide all the information requested in this section as well as in the forms included in Part 1 Section IV, Bidding Forms of the Bid Document.

Technical Proposals

1. Evaluation

The documents required for submission and evaluation of 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 stipulated in sub clause no. 1 of Section – III of PQ document used at the time of prequalification and **shall give an undertaking to this effect.** The Bidder shall fill up Form number BDF-2 and BDF-3 (Applicant information & Applicant party information) included in Section IV, Bidding Forms, Part 1 of Bidding Documents.

2.2 Personnel

The Bidder shall give an undertaking to arrange the following minimum key personnel of requisite experience and qualification (minimum graduate in relevant field) during the execution of the work in addition to semi-skilled and skilled staff.

SN	Key Position	Minimum Qualification	Minimum Qualifying experience Requirement	
			Total Work Experience (years)	In Similar Works Experience (years)
1	Project Manager	B.Tech	15	10
2	Deputy Project Manager (System Integrator)	B.Tech	10	5
3	Design Engineer (OHE)*	B.Tech	10	5
4	Design Engineer (Traction)*	B.Tech	10	5
5	Design Engineer (Signal)*	B.Tech	10	5
6	Design Engineer (Telecommunication)*	B.Tech	10	5
7	System Expert (TMS/CTC)*	B.Tech	10	5
8	Planning Engineer	B.Tech	10	5
9	Site Engineer (Signaling)	B.Tech	10	5
10	Site Engineer (Telecommunication)	B.Tech	10	5
11	Site Engineer (OHE)	B.Tech	10	5
12	Site Engineer (Traction Power supply)	B.Tech	10	5
13	Site Engineer (SCADA)**	B.Tech	10	5
14	Safety & Health Expert	B.Tech	5	3

15	Quality Assurance Expert	B.Tech	10	5

*** Can be of approved Specialized Sub-contractor's team**.

**** Can be from approved sub-contractor's team.**

2.3 Equipment

The Bidder shall demonstrate that it will have access to essential equipments/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 BDF-9 in Part-1, Section IV of Bidding Document.

SN	Name of Equipment
1.	Self propelled Rail cum Road Vehicle /work train for OHE wiring work
2.	Crane for OHE structure erection work
3.	Ready Concrete Mixing plant for Foundation work

List of Equipments /Plants are indicative and not exhaustive.

2.4 Subcontractors

The Bidder shall demonstrate in its proposal clearly the detailed scope of work and the value of the work to be carried out by its specialist subcontractors, including its proposed designer if the Design is not to be carried out in-house.

3. Financial Bid

The financial proposal will comprise the documents required as per ITB 10.5.

3.1. Evaluation

The evaluation of the financial bid shall be carried out in accordance with the provisions of ITB 29. Bidders shall submit financial Bid as per the Form –BDF-10 –Financial Proposal submission sheet as given in Part-5of the Bidding Document.

3.2 Time Schedule for Completion of Works:

The designated period for the completion and taking over the entire Works shall be 24 months (Twenty Four Months) from the Commencement Date, as indicated with further details in Para 8.2 of GCC. Bidders shall confirm that their Technical Proposals and Financial proposal are based on this Time Schedule for Completion. No credit of any kind will be given in the evaluation of Technical Proposals and Financial proposals, to a Proposal and/ or a Bid offering to complete the Works earlier than this designated period. However, Technical Proposals and Financial 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 Technical Proposal

1 Type of Contract

Technical and Financial Proposals are being invited for a Lump-Sum Contract, for Design and Construction, based on the Employer's Requirements.

The detailed design of all components as specified in Employers' Requirement Section-V will be carried out by the Contractor based on the Design Criteria and specifications as contained in Part-2, Section V(B),Vol.7,Vol.8 and Vol.9 of Employer's Requirement and "DESIGN STANDARDS" given in Appendix 14, Volume 6, Part 2- Employers' Requirement. Construction will be based on the "General Conditions of Contract read with Particular Conditions of Contract**".**

2 Documents Required for Technical Proposal

The Technical Proposal will comprise of the following documents in addition to the documents required as per Clause ITB 10:

2.1 General Submittal

S.N.	Form	Contents
1.	BDF-1	Technical proposal submission sheet.
2.	BDF-2	Applicant information
3.	BDF-3	Applicant's party information
4.	BDF-4	Draft Memorandum of understanding (MOU) for joint venture participation.
5.	BDF-5	Draft JV Agreement
6.	BDF-6	Proforma - letter of participation from each member of JV.
7.	BDF-7	Power of Attorney for authorize signatory of JV.
8.	BDF-8	Power of Attorney for lead partner of joint venture
9.	BDF-9	Contractors' Equipment
10.	BDF-9A	Form for Bid Security (Bank Guarantee)

2. 2 Technical Submittal

2.2.1 Methods Statement

The Bidder shall submit a method 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, procurement , Installation, testing & commissioningof material/equipment for
  - OHE, Traction Power Facilities, SCADA and E&M works
  - Signalling and Telecommunication,
  - TMS Work
- procurement/leasing/hiring of construction machines,
- 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.

- For the activities to be carried out by specialist subcontractor, method statement shall be submitted by shortlisted specialist subcontractor.

2.2.2 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, channel of communication, organization they come from and how this organization structure will manage the execution of the works within the scheduled period.

2.2.3 Work Plan

The Bidder shall submit a Work Plan which shall indicate how the Bidder intends to organize and carry out the Works by breaking them into various activities and completing those activities by appropriate **Milestones** within the time of completion as mentioned in GCC para 8.2. 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.
(Refer to Explanatory Note 1 at the end of this Section)

2.2.4 Documents for Safety and Quality Plans

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

a) Outline Safety Plan

b) Outline Quality Plan
(Refer to Explanatory Note 2 at the end of this Section)

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Explanatory Note No. 1

Reference Paragraph 2.2.3 Work Plan

Requirements of Work Plan

(1) The Bidder shall submit a Work Plan which shall indicate how the Bidder intends to organize and carry out the Works by breaking them into various activities and completing those activities by appropriate Milestones so that the whole of the work gets completed within the time of completion as mentioned in GCC para 8.2. 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. 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 V, "Employer's Requirements/ Volume 6 Appendix 3, PROJECT PROGRAM REQUIREMENTS"**

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

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

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

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

(d) 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.

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

(5) 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 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 any requirements for information on matters which would affect his works.

(6) 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.

(7) 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 of Contract.

******

Explanatory Note No. 2

Reference Paragraph 2.2.4 --Annexure-I - Documents for Safety and Quality 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 and Sub-Clause 4.8 and 6.7 of the GCC.

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 GCC 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.

Section IV. Bidding Forms

Table of Forms

Form No.	Description
BDF-1	Technical proposal submission sheet
BDF-2	Applicant Information
BDF-3	Applicant's Party Information
BDF-4	Draft memorandum of understanding (MOU[6])for joint venture participation
BDF-5	Draft format of joint venture agreement
BDF- 6	Pro-forma letter of participation from each partner of joint venture (JV)
BDF- 7	Format for power of attorney for authorized signatory of joint venture (JV) members – Power of Attorney
BDF- 8	Format for power of attorney to lead partner of joint venture (JV)
BDF-9	Contractor's Equipment
BDF-9A	Form for Bid security (Bank Guarantee)
BDF- 10	Price proposal submission sheet

[6] *In case of existing joint venture, the certified copy of JV Agreement be furnished.*

BDF-1

TECHNICAL PROPOSAL SUBMISSION SHEET

Date: .....

Invitation for Bid No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

To:.....

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-7);

(b) We confirm that our offer is fully compliant with Bid document and the Technical Proposals submitted by us, are in Clause by Clause Compliance with Employer's Requirement and other specifications, including Addenda thereon. We offer to execute the Works in conformity with the Bidding Document;

(c) We hereby confirm that we have carefully studied the Access Dates, Key Dates, Interfacing requirement with other designated agencies and contractors and technical and other details, specified in the tender documents, and confirm our compliance to the Key Dates specified in the Tender documents.

(d) Our bid shall be valid for a period of 180 days from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(e) If our bid is accepted, we commit to obtain a performance security in accordance with the Bidding Documents;

(f) If our bid is accepted, we commit to deploy key equipment and key personnel consistent with the requirements stipulated in Section-III : Evaluation and Qualification Criteria and Section-V of Employer's Requirement;

(g) If our bid is accepted, we commit to submit work method statements for all major activities and get these approved from the Engineers prior to commissioning of work on such activities. We also understand that the work shall be executed as per the approved methods statements without any deviations;

(h) We, including any subcontractors or suppliers for any part of the contract, do not have any conflict of interest in accordance with ITB 3.3;

(i) 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

(j) We have not made any tampering or changes in the bidding documents on which the bid is being submitted and if any tampering or changes are detected at any stage, we understand the bid will invite summery rejection and forfeiture of bid security/the contract will be liable to be terminated along with forfeiture of performance security, even if LOA has been issued.

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

Name .....

In the capacity of .....

Signed .....

Duly authorized to sign the Bid for and on behalf of .....

Date .....

BDF-2

Applicant Information Form

Date: *[insert day, month, year*]

IFP Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

Page*[insert page number]*of *[insert total number]*pages

Applicant's legal name *[insert full legal name]*
In case of Joint Venture (JV), legal name of each partner: *[insert full legal name of each partner in JV]*
Applicant's Actual or Intended country of constitution: *[indicate country of Constitution]*
Applicant's actual or Intended year of constitution: *[indicate year of Constitution]*
Applicant's legal address in country of constitution: *[insert street/ number/ town or city/ country]*
Applicant's authorized representative information Name: *[insert full legal name]* Address: *[insert street/ number/ town or city/ country]* Telephone/Fax numbers: *[insert telephone/fax numbers, including country and city codes]* E-mail address: *[indicate e-mail address]*
Attached are copies of original documents of ☐ Articles of Incorporation or Documents of Constitution, and documents of registration of the legal entity named above ☐ In case of JV, JV agreement, in accordance with ITB 3.1b.

Note:- In case of JV/Consortium fill only details of JV/Consortium and not of individual JV/Consortium members.

*****

BDF-3

Applicant's Party Information Form

[The following form shall be filled in for the Applicant's parties including partner(s) of a joint venture, subcontractors and Design Consultant]

Date: *[insert day, month, year]*

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

Page *[insert page number]* of *[insert total number]* pages

JV applicant legal name: *[insert full legal name]*
Applicant's Party legal name: *[insert full legal name of Applicant's Party]*
Applicant's Party country of registration: *[indicate country of registration]*
Applicant Party's year of constitution: *[indicate year of constitution]*
Applicant Party's legal address in country of constitution: *[insert street/ number/ town or city/ country]*
Applicant Party's authorized representative information Name: *[insert full legal name]* Address: *[insert street/ number/ town or city/ country]* Telephone/Fax numbers: *[insert telephone/fax numbers, including country and city codes]* E-mail address: *[indicate e-mail address]*

Note: Separate BDF form is required for all individual participants (members) in the JV as well as specialist sub-contractor and Design Consultant.

*****

BDF - 4

DRAFT MEMORANDUM OF UNDERSTANDING (MOU) For JOINT VENTURE PARTICIPATION BETWEEN*

M/s ……..…….. having its registered office at …..……..…… (here in after referred to as ……) acting as the Lead Partner of the first part,
and
M/s ……..…….having its registered office at ……..……..…. (here in after referred to as `…….') in the capacity of a Joint Partner of the other part.
and
M/s ……..…….having its registered office at ……. (here in after referred to as `…….') in the capacity of a Joint Partner of the other part.

The expressions of …….. and …….. shall wherever the context admits, mean and include their respective legal representatives, successors-in-interest and 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 work]……..."

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.
   i) Notice for Bid, and
   ii) Bidding document
   iii) Any Addendum/Corrigendum issued by Dedicated Freight Corridor Corporation of India Limited
   iv) The bid submitted on our behalf jointly by the Lead Partner.

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

3. M/s ……shall be the lead member 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 leader 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 partner which shall be expeditiously given by M/s……..……to M/s…….

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

(a) Lead Partner;
……...

(b) Joint Venture Partner
(i) ……..…….
(ii) …….
(iii) ……..……

[Similar details to be given for each partner]

5. JOINT AND SEVERAL RESPONSIBILITY

The Parties undertake that they shall be jointly and severally liable to the Client in the discharge of all the obligations and liabilities as per the contract with the Client and for the performance of contract awarded to their JV.

6. ASSIGNMENT AND THIRD PARTIES

The parties shall co-operate throughout the entire period of this MOU on the basis of exclusivity and neither 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 through its authorized representative shall receive instructions, payments from the Client. The management structure for the project shall be prepared by mutual consultations to enable completion of project to quality requirements within permitted cost and time.

8. BID SECURITIES

Till the award of the work, JV firm/Lead Partner of JV firm shall furnish Bid Security 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 all the parties in the ratio of their actual participation.

10. INDEMNITY

Each party hereto agrees to indemnify the other party against its respective parts in case of breach/default of the respective party of the contract works of any liabilities sustained by the Joint Venture.

11. For the execution of the respective portions of works, 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 in confidence and not use for any purpose related to the Project all commercial and technical information received or generated in the course of preparation and submission of the bid.

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 Indian Arbitration and Conciliation Act 1996 or any amendments thereof. The venue of the arbitration shall be Delhi.

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.

15. This MOU is drawn in …..... number of copies with equal legal strength and status. One copy is held by M/s ……..…… and the other by M/s…….& M/s …… and a copy submitted with the proposal.

16. This MOU shall be construed under the laws of India.

17. NOTICES

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

Lead Partner	Other Partner(s)
……	…….
(Name & Address)	(Name & Address)

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

M/s……..	M/s…….
……..……	……..
(Seal)	(Seal)

Witness

1……..(Name & Address)

2…….. (Name & Address)

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

*****

BDF- 5

DRAFT FORMAT OF JOINT VENTURE AGREEMENT

To be executed on non-judicial stamp paper of appropriate value in accordance with relevant Stamp Act and to be registered with appropriate authority under Registration Act.

The JV agreement shall be structured generally as per contents list given below:

A. CONDITIONS AND TERMS OF JV AGREEMENT

1. Definitions and Interpretation
2. Joint Venture – Include Equity of members, transferability of shareholding of equity of a partner leaving during the subsistence of the contract.
3. Proposal Submission
4. Performance – To indicate scope of responsibility of each member
5. Language and Law
6. Exclusively
7. Executive Authority
8. Documents
9. Personnel
10. Assignment and Third Parties
11. Severability
12. Member in Default
13. Duration of the Agreement
14 Liability and sharing of risks
15. Insurance
16. Sharing of Promotion and Project Costs, Profits, Losses and Remuneration
17. Financial Administration and Accounting
18. Guarantees and Bonds
19. Arbitration
20. Notices
21. Sole Agreement and Variation

B. SCHEDULES

1. Project and Agreement Particulars
2. Financial Administration Services
3. Allocation of the obligations
4. Financial Policy and Remuneration

*****

BDF- 6

PRO-FORMA LETTER OF PARTICIPATION FROM EACH PARTNER OF JOINT VENTURE (JV)

(To be executed on non-judicial stamp paper of appropriate value in accordance with relevant Stamp Act and to be registered with appropriate authority under Registration Act.)

No…. Dated

From:
……..
……..

To,

The Managing Director,
Dedicated Freight Corridor Corporation of India Limited
5th Floor, Pragati Maidan Metro Stn. Building Complex.,
New Delhi 110001.

Gentlemen,

Re: …"[Insert name of work]……..".

Ref: Your notice for Invitation for Bid (IFB) No. HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN dated ……..

1. We wish to confirm that our company/firm has formed a Joint Venture with (i)……. & ii)…….. for the purposes associated with IFB referred to above.

(Members who are not the lead partner of the JV should add the following paragraph).*

2. 'The JV is led by ……..…….. whom we hereby authorise to act on our behalf for the purposes of submission of Bid for ……..……. and authorise to incur liabilities and receive instructions for and on behalf of any and all the partners or constituents of the Joint Venture.'

OR

*(Member(s) being the lead member of the group should add the following paragraph)**

2. 'In this group we act as leader and, for the purposes of applying for Bid, represent the Joint Venture:

3. In the event of our JV being awarded the contract, we agree to be jointly with i) & ii) ……..…… (names of other members of our JV) and severally liable to the Dedicated Freight Corridor Corporation of India Limited, its successors and assigns 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.

4. *I/We, further agree that entire execution of the contract shall be carried out exclusively through the lead partner.

Yours faithfully,

(Signature)

(Name of Signatory)……

(Capacity of Signatory)……

Company Seal * Delete as applicable

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

****

BDF- 7

FORMAT FOR POWER OF ATTORNEY FOR AUTHORISED SIGNATORY OF JOINT VENTURE (JV) PARTNERS

POWER OF ATTORNEY*

(*To be executed on non-judicial stamp paper of the appropriate value in accordance with relevant stamp Act. The stamp paper to be in the name of the company who is issuing the power of Attorney*)

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 work of …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 and shall always be deemed to have been done by us.

Dated this the …… day of ……. 201__

(Signature of authorized Signatory)

Signature of Lead Partner	**Signature of JV Partner(s)**
……	**……**

(Signature and Name in Block letters of Signatory)

Seal of Company

Witness

Witness 1:	Witness 2:
Name:	Name:
Address:	Address:
Occupation:	Occupation:

**Notes:*

i) To be executed by all the partners jointly, in case of a Joint Venture.

*****

BDF- 8

FORMAT FOR POWER OF ATTORNEY TO LEAD PARTNER OF JOINT VENTURE (JV)

(*To be executed on non-judicial stamp paper of the appropriate value in accordance with relevant stamp Act. The stamp paper to be in the name of the company who is issuing the power of Attorney)*

POWER OF ATTORNEY*

Whereas Dedicated Freight Corridor Corporation of India Limited has invited Bids for the work of "Design, Supply, Construction, Installaltion, of 2x25 kV Electrification, Signalling & Telecommunication and associated works including Testing and commissioning for double track Electrified Railway line on Design Build Lump sum basis from Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya – New Durgauti section) of Eastern Dedicated Freight Corridor"

Whereas, the members of the Joint Venture comprising of M/s. ……..…., M/s. ……., M/s. ……, and M/s. ……. are interested in submission of bid for the work of ……..…… *[Insert name of work*] in accordance with the terms and conditions contained in the bidding documents.

Whereas, it is necessary for the members of the Joint Venture to designate one of them as the Lead Partner, 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, as may be necessary in connection the Joint Venture's bid for the project.

NOW THIS POWER OF ATTORNEY WITNESSETH THAT:

We, M/s. ……, hereby designate M/s. ……, being one of the partners of the Joint Venture, as the lead partner 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 bid, participating in conferences, responding to queries, submission of information/ documents and generally to represent the Joint Venture in all its dealings with the 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 till the contract agreement if successful, is entered into with the Dedicated Freight Corridor Corporation of India Limited and thereafter till the expiry of the contract agreement.

**To be executed by all the members of the JV except the lead member.*

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

We hereby agree to ratify all acts, deeds and things lawfully done by lead member, our said attorney, pursuant to this power of attorney and that all acts deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us/ Joint Venture.

Dated this the …… Day of …….. 201__

…….
(Signature)
……
(Name in Block letters of Executants)
Seal of Company

Witness 1:	Witness 2:
Name:	Name:
Address:	Address:
Occupation:	Occupation:

BDF-9

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. A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Bidder.

Item of equipment		
Equipment information	Name of manufacturer	Model and power rating
	Capacity	Country of Origin and Year of manufacture
Current status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	

Omit the following information for equipment owned by the Bidder.

Owner	Name of owner	
	Address of owner	
	Telephone	Contact name and title
	Fax	Telex
Agreements	Details of rental / lease / manufacture agreements specific to the project	

BDF- 9A
(Clause ITB-16; Section-I & II)

Form of Bid Security (Bank Guarantee)

BANK GUARANTEE

..... ***Bank's Name, and Address of Issuing Branch or Office.....***

Beneficiary: ***.....Name and Address of Employer.....***

Date: .....

Bid Security No.: .....

We have been informed that . . . . ***name of the Bidder***. . . . . (herein after called "the Bidder") has submitted to you its bid dated . . . . . (herein after called "the bid") for the execution of . . . . . [*insert*]. . of .. . ***name of work*** . . . . . under Invitation for Bid No. . . . . (“***the IFB***”).

Furthermore, we understand that, according to your conditions, bid must be supported by a bid guarantee.

At the request of the Bidder, 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*** . . . . .) upon receipt by us of your first demand in writing accompanied by a written statement stating that the Bidder is in breach of its obligation(s) under the bid conditions, because the Bidder:

(a) has withdrawn its bid during the period of bid validity specified by the Bidder in the Form of bid;

or

(b) having been notified of the acceptance of its bid by the Employer during the period of bid validity, (i) fails or refuses to execute the Contract Agreement, or (ii) fails or refuses to furnish the Performance Security, in accordance with the ITB.

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 performance security issued to you upon the instruction of the Bidder; and (b) if the Bidder is not the successful Bidder, upon the earlier of (i) our receipt of a copy your notification to the Bidder of the name of the successful Bidder; or (ii) **Ninety days (90) after the expiration of the Bidder's bid.**

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

This guarantee is subject to the Uniform Rules for Demand Guarantees**, ICC Publication No. 758.**

. . . . . ***.Bank's seal and authorized signature(s)*** . . . . . .

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

BDF-10

PRICE PROPOSAL SUBMISSION SHEET

Please refer Part-5 (Price Schedule) for this form

PART 2

Employer's Requirement

PART 2 – Employer's Requirements

Contents

डेडीकेटेड फ्रेट कोरीडोर

BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, INSTALLALTION, OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA – NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

SYSTEM WORKS CONTRACT PACKAGE

Issued on: 29.12.2017

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

Part -2, Section-V (A)

General Specifications

Employer:

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

A GOVERNMENT OF INDIA ENTERPRISE

under

MINISTRY OF RAILWAYS
INDIA

Volume 1 – Scope of Works

CONTENTS

1.0 General

1.1 Dedicated Freight Corridor Corporation of India (DFCCIL) is a Special Purpose Vehicle set up under the administrative control of Ministry of Railways to undertake planning & development, mobilization of financial resources and construction, maintenance and operation of the Dedicated Freight Corridors. In the first phase, DFCCIL will be constructing two corridors – the Western DFC and Eastern DFC- spanning a total length of about 3300 route km. The Eastern Corridor, starting from Ludhiana in Punjab and pass through the states of Haryana, Uttar Pradesh, Bihar, Jharkhand and terminate at Dankuni in West Bengal. The Western Corridor will traverse the distance from Dadri to Mumbai, passing through the states of UP, Delhi, Haryana, Rajasthan, Gujarat and Maharashtra.

The route alignment of Freight Corridors is mostly parallel to existing adjacent Indian Railway Track. However alignment is on detour at some locations to avoid social/environmental/wild life impact.

The Project entails construction of double-track electrified railway lines capable of handling 32.5 ton axle load, longer trains than currently used on Indian Railways. The bridges and other structures will be designed to allow movement of 32.5 ton axle load while the track structure will be initially designed for 25 ton axle load, operating at maximum train speed of up to 100 km/hr.

2.0 Project Information – Mughalsarai - New Sonnagar and Chiraillapathu station (excluding New Karwandiya – Durgauti section) of EDFC.

DFCCIL has awarded different civil and structure works contracts in Mughalsarai- New Sonnagar and Chiraillapathu section of Eastern Dedicated Freight Corridor for which most of the stretches are in advance stage of completion including important bridge over Sone river.

The construction of New Karwandiya to Durgawati (Approx 66 kms.) section between Mughalsarai to Sonnagar of EDFC is in the advance stage and likely to be commissioned shortly. The system works of the section Mughalsarai to Durgauti and New Karwandiya to New Sonnagar and Chiraillapathu has been taken in hand in this work. The section is generally parallel to the existing adjacent IR track. The western part of the section traverses through Chandauli district of Uttar Pradesh for approx. 40 km and eastern part is in Rohtas & Aurangabad district of Bihar.

The DFC junction station/cabin at around Chainage 6854m towards Howrah end of DFC Sone Bridge shall be connected to adjacent Chiraillapathu station of IR and shall be designated as New Chiraillapathu.

The New Sonnagar junction station of DFC shall be connected to Bagahabishunpur station of IR. The New Chiraillapathu junction station/cabin of DFC shall be connected to Chiraillapathu station of IR.

2.1. **DFCCIL intends to commission the aforesaid section of approx. 70 kms** between Mughalsarai to New Sonnagar and Chiraillapathu station (excluding New Karwandiya - Durgauti section) of Eastern Dedicated Freight Corridor. Accordingly invites bids on Design & Build Lump sum basis for Design, procurement, Construction of System works incorporating OHE, Traction Power Supply System), SCADA, E&M, Train Management System Work, Signaling & Telecommunication works and its testing & commissioning for double track railway line under construction for Eastern Dedicated Freight Corridor.

2.2 This section of Eastern DFC has five junction stations as under:

TABLE 2.2.

List of Junction, Crossing Stations and cabins on Balance Section of Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya - Durgauti section)

Station	Type	Approx. Chainage (IR)
New Chirailapathu	Junction Station	543/11-13

New Sonnagar Link	DFC Junction Station (connection with DFC lines only)	550/5A-5B
New Sonnagar	Junction Station	405.706 (From GMO)
New Ganjkhwaja	Junction Station	663.15 (from HWH)
New ERC Mughalsarai	Junction Station	669.4

Note: Junction Stations are those stations where there are connections between IR and DFC track.

3.0 Objective

3.1 The work on the Eastern section of the Dedicated Freight Corridor (DFC) between Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya-Durgauti section) approx.70 kms (henceforth referred to as "the Project") is to be constructed as double line electrified track with 25 kV AC 50 Hz, AT Feed System, capable of operating trains at a maximum speed of 100 km/h.

3.2 In full recognition of these objectives and with full acceptance of the obligations, the Contractor shall execute the Works taking into account all liabilities and risks that may be involved.

3.3 The Signalling and Communication, Train Management System Work, Building and Structure Work, Electrification (Traction Power Supply (TPSS) and Traction Overhead Equipment (OHE), SCADA and E&M etc. has to be carried out in a manner so as to permit the other contractors to carry out the balance civil engineering, structural and track works. The designs to be adopted should be such so as to permit the installation work by the other contractors simultaneously. The Contractor shall be required to interface, coordinate and cooperate with Civil, structure and Track Contractor(s) in such a way that complete project is commissioned successfully in a time bound manner.

4.0 Scope of work in brief

The work under the scope of this bid consists of Design, construction, supply, installation, testing and commissioning of 2x25 kV electrification, signaling &telecommunication and associated works for the double track railway line under construction on design build lump sum basis from Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya- Durgauti section) approx.70 kms on Mughalsarai- Sonnagar Section of Eastern Dedicated Freight Corridor. The Employer requires that these works are designed and constructed to the highest standard using proven upto date good practices.

Henceforth all these works in this chapter would be termed as permanent works. All works required to facilitate construction of permanent works would be termed as temporary works.

4.1 All the works shall be carried out as per "Employer's Requirements" Part 2 Section V(A) & V(B). Summary of the works required to be carried out is provided in the ensuing paragraphs. Detailed location for the work is as given below:

	From Mughalsarai to Durgauti	From New Karwandiya to New Sonnagar & Chirailapathu	Total length
	Route KM (Approx.)	Route KM (Approx)	KM (Approx.)
Up Road DFC	**40.25**	**30.08**	**70.33**
Dn Road DFC	**40.45**	**29.89**	**70.34**

4.2 The Contractor shall undertake the Design, construction, manufacture, supply, installation, testing and commissioning of Signalling and Communication, Electrification (Henceforth, to mean comprising 25 kV Autotransformer Feed Type Traction Power Supply System (TPSS) and corresponding Traction Overhead Equipment (OHE), SCADA and E&M, Train Management System Work of the double track railway system including interface with IR/Utilities.

4.3 The design of all the works will be operationally compatible with the other Indian Railways (IR) and DFCCIL sections connecting to the Project. All the Signalling & OHE works on IR stations/yards except interface works with DFC in connection with Yard remodelling shall be carried out by IR and is not a part of the scope of work of this contract.

4.4 The Contractor shall be responsible for addressing design development from preliminary stage to detailed design including obtaining No Objection Certificate (NOC) and approval from relevant authorities, and construction interfaces with all other applicable railway systems of the Project and Indian Railways (Civil, Structures and Track, Signalling, Telecommunications, TMS, SCADA, OHE, Traction Power Supply and Traction Rolling Stock), and systems of public services, utilities and third parties, etc. which are located adjacent or parallel to the Project.

4.5 The Contractor shall undertake the rectification of defects and deficiencies appearing in the Permanent Works of this Contract during Defect Notification Period (DNP) in the manner and to the standards as stipulated by the Contract.

4.6 The Contractor shall also be responsible for:

a) Safety relating to all items designed for the construction process and the development of a system safety plan.

b) Quality management, quality assurance accreditation, quality control methodology identified within a quality manual, which shall include methods of traceability, certification relating to testing and storage systems for retrieval and protection. The quality assurance programme shall be complaint to ISO 9001: 2008.

c) The production of construction, maintenance and operation manuals, preparation of Station Working Rules (SWR), Gate Working Rules (GWR), Commissioner of Railway Safety (CRS)/Electrical Inspector to Government of India(EIG) application & REPC clearance from DOT.

d) Supply of spares.

e) Supply of all maintenance tools testing equipment and M&P.

f) Training of the Employer's personnel

4.7 Signalling, TMS and Building and Structure works

The particular specifications of signalling work including TMS and building and Structure work is given at Part 2, Section V(B): Particular Specification, Vol. 7

4.8 Communication System works

The particular specifications of telecom works is given at Part 2, Section V(B): Particular Specification, Vol 8.

4.9 Electrical Works

The particular specifications of Electrical works is given at Part 2, section V(B): Particular Specification, Vol 9.

4.10 Temporary Work

The Contractor shall execute all Temporary Works required to facilitate construction 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 that these remain safe during construction. As a rule temporary Works shall be subsequently dismantled

and removed by the Contractor after construction 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.

4.11 Incidental Works

In addition to above the Contractor shall undertake various incidental Works to complete the entire project successfully. The Contractor shall include cost of such incidental Works in his Bid price. Some of the incidental Works are listed below:

(i) **Site Safety Compliance**: - The Bidder shall submit as part of his bid a Site Safety Plan which shall be in accordance with Part 2, Volume 6, Appendix-12 Site Safety Plan

(ii) **Quality Assurance:**-The Bidder shall submit as part of his bid a Quality Assurance Plan which shall include Quality Assurance procedures and regulations to be developed and the mechanism by which these will be implemented for ensuring Quality compliance as per the Employer's Requirements **detailed in Appendix 6, Volume 6, Part 2 of Bidding Document**.

(iii) **Interface Management**: - The Contractor for this Work shall cooperate and coordinate with Civil Engineering contractor as well as Track Contractor and shall bear the responsibility for Interface management for System works with other Contractors and agencies. After award of Contract the Contractor shall submit an Interface Management Plan which shall include procedures and regulations to be developed and the mechanism by which Interfacing will be implemented as per the Employer's Requirements detailed in **Appendix 3, Volume 6, Part 2 of Bidding Document**.

(iv) **Integrated Testing and Commissioning**:- The Contractor for this Work shall be required to conduct & extend all necessary help for Integrated test for the entire System in coordination with other Contractors and agencies to meet the requirements as mentioned in the Bid Document.

(v) In case, the management of traffic around the worksite becomes necessary, the Contractor shall carry out the same at his cost. The Engineer however, may at times request the Contractor to retain the temporary diversion of the road in place. All such requests by the Engineer shall be entertained by the Contractor.

(vi) While working in close proximity of existing IR track, the Contractor shall obtain permission for Works with or without traffic block from concern Railway authority/interfacing agencies wherever applicable and DFCC shall assist in obtaining such permits. Extra precautions to be observed by the Contractor while working in close proximity of existing Indian railway track as listed in **Volume 5, Manufacturing, supply, installation, testing & commissioning Part 2 Employer's Requirements**.

(vii) Office accommodation for Engineer and Employer including inspection and transport facilities as specified in **Appendix 15, Volume 6, Part 2 of Bidding Document.**

(viii) Benchmarking, setting out, photography, videography, report submission, permanent markers like cable markers, signages, boards etc. As Built drawings, inspection books, registers for record & maintenance of system works as specified in Section V(A) and V(B) **Part 2 Employer's Requirements.**

(ix) The Contractor shall be responsible for obtaining relevant certificates or clearances from local/civil authorities/Commissioner of Railway Safety viz. completion certificate, fire clearance or any other mandatory clearances which may be specified by these authorities from time to time.

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Section V(A). Employer's Requirement: General Specifications Volume 2 – General

1.0 INTRODUCTION

1) The work under the scope of this bid consists of Design, supply, construction, installation, of 2x25 kV electrification, signaling & telecommunication and associated works including testing and commissioning for double track electrified railway line on design build lump sum basis from Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya-New Durgauti section) approx. 70 kms on Mughalsarai-Sonnagar Section of Eastern Dedicated Freight Corridor. The Employer requires that these works are designed and constructed to the highest standard using proven upto date good practices.

2) The Employer's Requirement has been divided into two sections as under:

SECTION V (A): General Specification

Volume 1: Scope of Works
Volume 2: General
Volume 3: Design Procedures and Processes
Volume 4: Design Criteria and Specifications
Volume 5: Manufacturing, supply, installation, testing & commissioning Volume 6: Appendices

SECTION V (B) : Particular Specification

Volume 7. Particular Specifications for Signalling works
Volume 8. Particular Specifications for Telecommunication works
Volume 9. Particular Specifications for Electrical works

2.0 DEFINITIONS AND INTERPRETATIONS

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

(a) **"As-Built Drawings":** means those drawings produced by the Contractor and endorsed by it as true records of construction of the Permanent Works and which have been agreed with the Engineer.

(b) **"Condition of Contract":** shall mean General Conditions of Contract (Section VI, Part 3) read in conjunction with Particular Condition of Contract as in **Section VII, Part 3 of Bid Document.**

(c) **"Construction 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.

(d) **Manufacture & Supply Phase and Installation, Testing, Commissioning phase:** has the meaning identified in para 4 of this Volume.

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

(f) **"Definitive Design":** prepared and accepted part of drawings, documents, standards, and instructions, which give the abilities for supply, installation and testing. Giving clearance by the Engineer, to the Definitive Design is an obligatory condition for the commencement of construction Works. "Definitive Design" has the meaning identified in **Part 2 "Employer's Requirement, Section V A, Volume 3, Design Procedures and Processes" for System Works** of the Bid Document.

(g) **"Definitive Design Submission":** means the submission of Contractor's Documents which comprise the whole or parts of the proposed Definitive Design and for which the Contractor seeks a Notice.

(h) **"Design Criteria":** means the governing specifications and conditions as specified in Employer's Requirement Volume 4 and in **Section V(B) of** Particular Specification of Bid Document.

(i) **"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.

(j) **"Design Manual":** means the manual to be prepared and submitted by the Contractor as part of the Preliminary Design and as described in , **Part 2 "Employer's Requirement, Section V (A), Volume 3, Design Procedures and Processes "** of the Bid Document as applicable.

(k) **"Design Phase":** has the meaning identified in para 4 of this chapter.

(l) **"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.

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

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

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

(p) **"Key Date"** means the date identified as such in the Contract **"Employer's Requirement, Section V(A), Volume 6, Para 2; Appendix 4 – Project Program Requirements"**.

(q) **"Milestone"** means as defined in clause 1.1.3.10 of GC

(r) **"Milestone Date"** means the date prescribed in Schedule of Milestones by which a Milestone is to be achieved - **Employer's Requirement, Section VI, Volume 6, Para 2; Appendix 4 – Project Program Requirements"**.

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

(t) **"Notice":** means a Notice of No Objection.

(u) **Deleted**

(v) **"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, submitted during First Stage Technical Proposal.

(w) **"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 safety as prescribed in the **Employer's Requirements Part 2**.

(x) **"Preliminary Design":** means the submission of Contractor's Documents which comprise the initial stage of the design phase.

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

(z) **"Railway"** means Railway or any portion of a Railway for public carriage of passengers and goods as defined in the Railway Act 1989. Any reference to railway means the Indian Railways and the respective Zonal Railway.

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

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

(cc) **Deleted.**

(dd) **"Safety Procedures":** these shall be the procedures as detailed in Part-2, Section – V(A)**, Volume-6, Appendix -12, Employer's requirement.**

(ee) **"Schedule of Milestones":** means the schedule included in sub clause 8.2 of Time of Completion **– Part 3, section VII of Bid Document**.

(ff) **"System Works":** means the work connected with design, construction, manufacture, supply, installation, testing and commissioning related with electrification of Railway line, signalling and control systems, telecommunication system. SCADA control system, E & M works, allied service buildings required for system works removal of any temporary works as included in the scope of work for system works.

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

(hh) **"Technical Specification":** 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, installation and construction-testing-commissioning which are developed during the Design Phase and fully comply with the Employer's requirements.

(ii) **"Works"** also 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 Materials and their accessories.

(jj) **"Working Drawings":** comprise the drawings and documents, such as construction drawings, manufacturing drawings, installation drawings, and testing and commissioning documents as are necessary to amplify the Good for construction Drawings for construction etc purposes and endorsed, as required, by the Engineer.

(kk) **"Works Programme"** means the programme 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 Employer's Representative has issued a Notice of No Objection.

3.0 RELEVANT DOCUMENTS

These documents shall be read in conjunction with the Conditions of Contract (General and Particular), Employer's Requirement and any other document forming part of the Contract. This design-build contract shall be fulfilled, managed and commissioned in accordance with the applicable legislation in India, specific IR regulations and railway operations manuals and where none exist with applicable international norms where appropriate. Tentative list of standards is enclosed in **Part 2 "Employer's Requirement, Section V (A), Volume 6, Appendix 14 - Design Standards"**

4.0 DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING

(1) The Contractor shall execute the System related works in four (4) phases;

(a) Phase 1- Design Phase

(b) Phase 2, The Manufacture & Supply Phase

(c) Phase 3, The Installation, Testing and Commissioning phase ; and

(d) Phase 4, the Defect Liability Phase.

(2) The Design Phase shall begin from the Commencement Date of the Contract. This phase shall include the preparation and submission of:

(a) the Preliminary Design and Drawings;

(b) the Definitive Design and Drawings;

(3) The Manufacture & Supply Phase (comprising the procurement, manufacture of plant, production of materials, testing, supply and delivery) for the whole or a part of the Permanent Systems Works shall commence immediately upon the issue by the Engineer of a Notice in respect of the relevant Drawings Submission. Such Notice may be issued by the Engineer in respect of a Drawings Submission covering a major and distinctive part of the Permanent Works. .

(4) However, manufacture shall not commence until the original copies of the appropriate Working Drawings relating to manufacture have been endorsed by the:

(a) Contractor as "Good for Manufacture";

(b) Engineer that he has no objections to these drawings.

(5) The Manufacture and Supply Phase will be completed upon the issue of a Notice in respect of the comprehensive and complete Manufacture & Supply Verification Submission for the whole of the Permanent Systems Works.

(6) The requirements for the procurement, manufacture of plant, production of materials, testing, supply and delivery are stated in **Volume 5 "Employer's Requirements Section V(A) Part 2. Manufacture, Supply, Installation, Testing & Commissioning and Section V(B) of Particular Specification.**

(7) The Installation-Testing-Commissioning Phase for the whole or a part of the Permanent Systems Works shall commence immediately upon the issue by the Engineer of a Notice in respect of completion of the relevant Manufacture & Supply Verification Submission. Such Notice may be issued by the Engineer in respect of completion of manufacturing and supply of a major and distinctive element comprising part of the Permanent Systems Works.

(8) However, installation shall not be commenced until the original copies of the appropriate Working drawings relating to installation at (7) above have been endorsed by the:

(a) Contractor as "Good for Installation";

(b) Engineer that he has no objections to the drawing;

(9) The requirements for installation, testing and commissioning and all associated activities (spares, training etc), are stated in **Volume 5, "Employer's Requirements Section V (A) Part 2. Manufacture, Supply, Installation, Testing & Commissioning"** and in **Section V(B) of Particular Specification.**

(10) The Installation-Testing-Commissioning Phase shall include the completion and submission of the Final Design and the preparation and submission of the As-Built Drawings and other records as specified.

(11) The defect liability phase shall commence immediately upon taking over of the section and issue of necessary certification thereof by the Engineer.

(12) This Notice may be in respect of each such element subject to availability of the site in accordance with agreed programme.

5.0 SPECIFICATIONS

(1) The Technical Specifications for the Works shall comply with Standards and Design Codes which are in accordance with or defined and listed in section V(A) & V (B) including outline materials and workmanship specifications if any.

(2) In accordance with the provisions of these documents, the Contractor shall develop the Technical Specifications during the Design stage and submit it as part of the Definitive Design Submission.

(3) When the Specifications have received a Notice of No Objection from the Engineer, these shall become the Technical Specifications.

6.0 UNIT OF MEASUREMENTS

The Contract shall utilize the SI system of units.

7.0 WORKS PROGRAMME

(1) The Contractor shall prepare and submit its Works Programme and three (3) months rolling programmes as defined in the detailed requirements contained in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 4 - Project Program Requirements"**.

(2) The Stages and the Key Dates are as defined in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 2 - Works Areas and Contract Stages"** and are based on the Project Calendar as defined at **Part 2 "Employer's Requirement, Section V (A), Volume 6, Appendix 9 - Project Calendar"**.

8.0 MONITORING OF PROGRESS

(1) The Contractor shall submit to the Engineer **five** copies of a Monthly Progress Report (MPR) in English and on CD/DVD, as described in **Part 2 "Employer's Requirement, Section V (A), Volume 6 Appendix 5 - Monthly Progress Reports"**.

(2) Engineer will require the Contractor to attend monthly management meeting or any other meetings in order to review the arrangements for future Work, Works progress or other issues set out in the agenda of the meeting. The minutes of the meeting signed by the Contractor and the Engineer shall constitute an official record of matters discussed, but shall not replace any requirement in the Contract for approvals, instructions or decisions to be submitted in writing. Such meetings may be attended by representatives of all Interfacing Parties and other stakeholders as deemed fit by the Engineer or Employer at his discretion. The Employer may also be present in the meeting.

9.0 SITE SAFETY PLAN

(1) The Contractor shall establish and maintain various provisions of Site Safety Plan as detailed in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 12**

10.0 QUALITY ASSURANCE

(1) The Contractor shall establish and maintain a Quality Assurance System in accordance with **Part 2 Employer's Requirement, Section V(A), Volume 6, Appendix 6 - Quality Assurance"** for the design, construction procedures and the interfaces between them.

(2) The Quality Assurance Plan shall, without limitation, include for quality assurance procedures for Design, Construction, Manufacturing, Supply, Installation, Testing and Commissioning and shall control processes for each stage in the Works such as for design verification and validation, management of change control, non-conformance procedures, inspection, testing, auditing and the like.

11.0 CO-ORDINATION WITH INTERFACING AND OTHER PARTIES

(1) The Contractor is responsible for detailed co-ordination of his design, manufacturing, installation, construction, testing and commissioning activities and will take the lead in the management of the coordination process with IR, interfacing contractors, utility agencies, statutory authorities, private service providers, consultants and other contractors whether or not

specifically mentioned in the contract that may be working on or adjacent to the site for the purpose of the Project.

(2) For the purpose of these general specifications, Contractor's responsibilities are listed at **Part 2 "Employer's Requirement, Section V (A), Volume 6, Appendix 3 - Design and Construction Interfaces"** and in Particular specification, Section V(B).

12.0 SURVEY AND SITE INVESTIGATIONS

The Contractor shall carry out survey and all further site investigations as necessary for the design of the System related Works and to enable the determination of the methods of construction and the nature, extent and design of the Temporary Works.

13.0 PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

The Contractor shall devise and utilize a PMIS such that all documents generated by the Contractor can be transmitted to the Engineer by electronic means. The PMIS shall also allow all documents generated by either party to be electronically captured at the point of origin and be reproduced later, electronically and in hard copy. Requirement of PMIS are explained in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 4 - Project Program Requirements".**

14.0 PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHTS

In so far as the patent, copyright or other intellectual property rights in any Plant, Design Data, plans, calculations, drawings, documents, materials, 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, non-exclusive and irrevocable license to use and reproduce any of the Works, Designs or inventions incorporated and referred to in such plant, documents or materials 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.

15.0 LANGUAGE OF CONTRACTOR'S DOCUMENTS

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

16.0 ALIGNMENT & YARD PLANS

(1) The proposed alignment, yard plans listed in **Part 4 "Reference Documents."** are for reference purpose only.

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

(3) It will be presumed that Contractor has taken note of all effects of these constraints on his construction operations to ensure on-time completion of the Works.

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

17.0 CLEARANCES

The Permanent works shall not infringe the schedule of dimensions and land boundary limits of DFCC as shown on the drawings as listed in **Part 4:Reference Documents.**

18.0 CLIMATIC CONDITIONS

(1) **Project Area:** The Works will be carried out between Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya- Durgauti section) in the state of Uttar Pradesh and Bihar. The proposed alignment is generally parallel to the section of Indian Railways. .

(2) The project length from Mughalsarai to New Sonnagar and Chirailapathu station (excluding New Karwandiya- Durgauti section) falls along the Tropic of Cancer. The climatic and atmospheric conditions for the section are given in part 2 of Employer's Requirement, Section V(B), Vol.-9 Particular Specifications for Electrical Works.

19.0 STANDARDS

(1) Equipment, materials, and systems shall be designed, manufactured and tested in accordance with the latest issue as on base date of approved and recognized codes and standards as given in Part-2, Employer's Requirement, Section V (A), Volume 6 Appendix -14- Design Standards" and Section V(B) Particular Specifications . The contractor shall be responsible to adopt the latest version of these codes and standards including all amendments thereof.

(2) The Contractor shall provide to the Engineer two original full editions of the publications (such as, but not limited to, Technical Standards, specifications and Codes of Practice), the codes and standards proposed for carrying out the Designs, Contractor's Documents, the Drawings and other communications relevant to this Contract. The Contractor shall provide list of all such standards and specifications, which form the basis of his design activities within 28 days of Commencement Date. A copy of other publications referenced in other communications between the Engineer and the Contractor shall be provided by the Contractor to the Engineer within 28 days following the issue of such other communication. These publications shall be for the sole use of the Engineer and Employer and, upon completion of the Contract, shall become the property of the Employer.

20.0 PUBLICITY

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

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Section V (A), Employer's Requirement:
General Specification
Volume 3 – Design Procedures and Processes

1.0 INTRODUCTION

(1) This document specifies the procedural requirements for the preparation of the Design.

(2) In addition to the requirements stated herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to Design matters.

(3) The Contractor shall, in accordance with Clause 5.1 of the General Conditions of Contract engage the designer(s) who shall undertake and prepare the Design of the Works.

(4) The Contractor shall establish an office for his core design team at a suitable location near Engineer's office. All meetings and discussions relating to design shall be held in that office or the office of Engineer/Office of Employer (either in Field or in HQ).

(5) The Contractor shall ensure that the Designer and his team continue to be represented in India (Project Design Office) by staff whose seniority and experience in their respective fields of activity, are to the satisfaction of the Engineer. The contractor shall also undertake that the designers shall be available to attend discussions with the Engineer and Employer at all reasonable times during the contract period.

(6) The key Designers who shall formally sign the Design must have the necessary qualification required by the applicable legislation in India, as well as their engineer's degree/diploma being recognized in India.

(7) The Contractor shall submit his Quality Assurance Plan for the Design required in the Contract as specified in "**Part 2 Employer's Requirement, Section V(A) , Volume 6, Appendix 6 - Quality Assurance".**

(8) The contractor shall submit CV of all the concerned personnel of Key Position to the Engineer for approval, whose designation have been mentioned in bid document, before deputing them at project site.

2.0 REQUIREMENTS DURING THE DESIGN PHASE

(1) The principal requirements of the Design Phase are the production of the documents by the Contractor, which shall fully describe the Works and include the Preliminary Design, Definitive Design and "Good for Construction Drawings".

(2) The volume and contents of the documents shall be in accordance with the applicable regulations/legislation in India, existing codes, manuals and standards applicable on Indian Railways and suitable international norms.

(3) The Contractor shall obtain all necessary approvals and agreements for his designs on his account in accordance with the applicable legislation in India & current practices.

(4) The Preliminary Design shall incorporate the design and Reference Drawings included in the Bid Document, and to be developed by the Contractor sufficiently to define the system related works.

(5) In addition, general construction, manufacture, installation, testing and commissioning methodologies and documentation needed to develop the Definitive Design shall be submitted.

(6) The Definitive Design shall accord with, and incorporate the Contractor's Proposals and shall be the design developed to the stage at which all elements pertaining to Works are fully defined and specified. In particular the Definitive Design shall be complete when:

(a) All calculations and analyses are complete including verification;

(b) All main and other significant elements are defined;

(c) All tests, trials and selection of materials and equipments are complete;

(d) The effects on the Permanent Works of the proposed methods of construction, installation, testing and commissioning and on the Temporary Works are assessed.

(7) During the preparation of the Definitive Design, all surveys, and testing necessary to complete the Design of the Permanent and Temporary works shall be undertaken by the Contractor.

(8) Two hard and soft copy of the Design of System related works shall be submitted for approval to the Engineer. After approval of the definitive design of System works, three additional hard copies in a bound book form and one softcopy should be provided by the Contractor.

(9) After approval of the Engineer the Contractor may proceed to the next stage of the Project for obtaining notice of No Objection.

(10) Upon issue of the Notice in respect of the Definitive Design Submission, the Contractor shall complete the Design in all respects and produce the "Good for Construction Drawings", the purpose of which is to illustrate all the Permanent works and to be the drawings governing the Construction.

(11) These drawings shall fully detail the Construction of the elements covered by the Definitive Design, and shall show in full, the Works to be constructed.

(12) The Contractor shall prepare the necessary sets of his designs in English for submitting to the relevant authorities responsible for the approvals in accordance with the contractual provisions & the applicable legislation in India.

(13) Detailed requirement of design phase for various systems components is given in part 2 section V(B), Particular Specifications.

3.0 REQUIREMENT FOR ALIGNMENT AND LAND

The contractor is to develop the definite design within the function completed and the land acquired or proposed to be acquired by the employer for the project as applicable.

4.0 REQUIREMENTS DURING CONSTRUCTION PHASE

(1) The principal requirements relating to the Contractor's documents during the Manufacture, Supply, Installation, Testing and Commissioning Phase are the production by the Contractor of Working Drawings and documents, the preparation of technical submissions as required under the Contract, the compilation of the final design and the production of the As-Built Drawings and final documentation.

(2) Working Drawings and documents shall be prepared as required under the Contract.

(3) The Contractor shall endorse the Working Drawings and documents as being in accordance with the Definitive Design and "Good for construction drawings".

(4) Additionally the requirements of **Volume 5, "Employer's Requirements/ Performance Specifications, Section V(A) Manufacturing, Supply, Installation, Testing and Commissioning" and Section V(B), Particular Specifications** are to be complied with.

(5) The Contractor shall endorse the submissions required under the contract that "all effects of the designs comprising the submission, on the design of adjacent or other parts of the works have been fully taken into account in the design of these parts".

(6) The final design is the design of the Permanent Works embodied in:

(a) The latest revisions of the documents comprising the Definitive Design, taking account of comments in the schedules appended to Notices of No Objection;

(b) The latest revisions of all the drawings;

(c) The calculations (see **Clause 13.0 Calculations** herein); and

(d) Such other documents as may be submitted by the Contractor at the request of the Engineer to illustrate and describe the Permanent Works and for which a Notice has been issued.

(7) Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings and final documents.

(8) All such drawings and documents shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all Temporary Works that are to remain on the site.

(9) Where the Contractor temporarily requires additional land, for the period of construction to facilitate the construction, the contractor shall arrange for the same entirely at his own cost and risk.

(10) The Contractor shall maintain all records necessary for the financial completion and commissioning. These records shall form part of completion report and shall consist of as a minimum.

(a) The implemented work according to activities, places and price;

(b) Used materials – type, name of manufacturer along with batch No., Drg No. Specification no., place & price etc;

(c) Any other records as required.

5.0 DESIGN INTERFACES WITH INTERFACING CONTRACTORS

(1) The Contractor shall be responsible for all co-ordination of all design and installation work with the various interfacing parties including interfacing contractors, to establish the co-ordinate Installation Plan (CIP) as defined at **Part 2 "Employer's Requirement, Section V(A), Volume 6,Appendix 3 - Design and Construction Interfaces"**.

(2) The CIP shall be prepared by the Contractor in a format acceptable to the Engineer.

(3) The Contractor shall co-ordinate with all Interfacing Contractors and Parties to produce a detailed programme of access dates, equipment delivery routes and occupation periods for each equipment room and area inside the Railway envelope.

6.0 PLANNING SUBMISSION

Submission for approval of planning of works for the project shall be made by the contractor to the relevant authorities.

7.0 DESIGN SUBMISSION

The Design Submission shall be a complete set of Contractor's documents properly consolidated and indexed and shall fully describe the proposed Design.

7.1 Preliminary Design Submission

The Preliminary Design shall provide initial design documents for review of all elements of construction and shall be sufficiently detailed to show the elements of the design and documents required for preparation of the Definitive Design. The preliminary design should take into account as far as possible all the interface requirements identified by the Contractor at this stage. It shall also include, but not be limited to:

7.1.1 General

a) The quality assurance plan for design;

b) A review of the outline design criteria;

c) The Design Manuals;

d) Submission of specifications proposed for the work;

e) The identification of design codes and standards;

f) The preliminary maintenance analysis;

g) The preliminary off site testing recommendations;

h) The preliminary testing and commissioning report;

i) The submission of proposed software;

j) The CAD procedures;

k) The preliminary equipment layouts and details;

l) Preliminary equipment sizing;

m) Preliminary equipment proposals;

n) Preliminary installation and construction methodology;

o) Design submission programme (update);

p) Proposed site surveys and other field surveys.

7.2 Definitive Design Submission

The Definitive Design Submission shall be a complete set of Contractor's documents, properly consolidated and indexed and shall:

(a) Fully describe the proposed Definitive Design;

(b) Provide substantiation and justification for the recommended design, including the consideration of a range of options;

(c) Be submitted in sufficient time to allow the Engineer to consider and approve prior to the commencement of manufacture and/or installation;

(d) Prove that the design complies with all relevant design, performance, functional and other requirements as are specified or implied in the Tender Documents, under normal and all applicable degraded/failure modes.

7.3 Documents Submission

The Contractor's technical proposals shall be amplified during the Preliminary and Definitive Design as required above and shall include but not be limited to the following documents:

7.3.1 Technical specifications

(1) The Specifications included in the Contractor's technical proposals together with the Design criteria shall be amplified so as to comprehensively specify the design and construction of the Works.

7.3.2 Design Manual

(1) The Design Manual shall incorporate all design requirements, standards, codes and all other documents or matters which are relevant to and govern the design.

(2) In addition it shall refer to all materials, codes and standards used, making clear their specific applications.

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

7.3.3 Report on interfacing contracts

(1) The report shall include details of the Design and Construction of the Works sited adjacent to other contracts, details of provisions required to be provided by the Interfacing Contracts, indicating arrangements for accesses, fixings, casting-in, openings, supports, decks, manholes, trenches and the like, equipment installation in other Interfacing Contractor's works along with updated interface management plan relating to design integration and co-ordination.

7.3.4 Testing and commissioning reports

The report shall include details of proposals for testing and commissioning procedures for all relevant elements and equipment contained in the Permanent Works.

7.3.5 Maintenance reports

The report shall be updating the statement of maintainability in the Contractor's technical proposals and detailing maintenance routines necessary for the achievement of the required life of the various elements of the Works.

7.3.6 Supporting documents

Where relevant or required, these documents shall be accompanied by a design note stating clearly how the information has been used in the design of the Permanent Works.

7.3.7 Construction / manufacturing / installation analysis reports

A report shall be containing a stage-by-stage construction / manufacturing / installation sequence for all structures/ equipment.

7.3.8 Construction method statements

A report shall provide sufficient information on the methods of Construction / Installation of the Contractor's Equipment to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design.

7.3.9 Survey report

The report shall cover all survey work undertaken by the Contractor.

7.3.10 Temporary works design report

The report shall provide sufficient information on the design of the Temporary Works to allow the Employer's Representative to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design.

7.3.11 Project schedule review

(1) The Contractor shall, prior to submitting the Design Submission, review the project schedule against the current version of the Design Submission Programme.

(2) The Design submission programme should be in accordance with the Project Schedule.

(3) In the event that the Contractor considers there to be any discrepancies or inconsistencies between the design submission programme and the project schedule, the Contractor shall submit with the Definitive design submission programme, its proposed revisions to the project schedule such that the discrepancies or inconsistencies are removed.

(4) The Contractor shall provide details of submissions of the proposed Working Drawings and documents and their anticipated timing during the construction phase.

(5) The Contractor shall identify information required from or actions to be undertaken by the Employer or others and which are necessary to permit the completion of the design of the Permanent Works and the Working Drawings and documents.

(6) Dates of the receipt required by the Contractor of such information or for the completion of such actions shall be included with appropriate justification.

8.0 DESIGN SUBMISSIONS – GOOD FOR CONSTRUCTION DRAWINGS

(1) These drawings shall form part of the Working Drawings to be used for construction purposes.

**9.0 DESIGN SUBMISSIONS –
MANUFACTURE, SUPPLY, INSTALLATION, TESTING & COMMISSIONING PHASES**

(1) In accordance with the **Volume 5. "Employer's Requirements Section V(A) Part 2 Technical Requirements, Manufacture, Supply, Installation, Testing and Commissioning" and Section V(B), Particular Specifications,** the Contractor shall identify submissions required during the Manufacture & Supply and Installation-Testing-Commissioning Phases.

(2) On the issue of a Notice in respect of the Good for Construction Drawings, the Contractor shall produce the proposed Working Drawings.

(3) These shall either be identical to the Good for Construction Drawings or shall be further drawings and documents developed in accordance with these drawings such as fabrication and shop drawings, construction installation and erection sequences and the like and all such drawings shall comply with the requirements of the Contract.

(4) Prior to submission of the proposed Working Drawings, the Contractor shall endorse the appropriate original paper drawings as "Good for Construction".

(5) If the Engineer so requires, the endorsed original shall be submitted to the Engineer who shall, if he has no objection to the contents of the submission, further endorse the original by stating that he has no objection to the proposed Working Drawings.

(6) On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings.

(7) Only the Working Drawings endorsed as above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site and the construction of the Works shall be strictly in accordance with these Working Drawings.

(8) The manufacturing and installation of the Works shall be strictly in accordance with these Working Drawings

(9) The Contractor shall finalise details of the proposed method of construction and/or installation and submit such finalised details to the Engineer for review.

(10) As-built Drawings and documents shall be submitted to the Engineer for approval within the time period as mutually agreed by the Engineer and the Contractor.

10.0 DESIGN SUBMISSIONS - REVIEW PROCEDURES

(1) Design submissions shall be reviewed by the Engineer who shall coordinate the design review for the Employer and communicate the decision within 28 days of receipt of complete information on the subject matter.

(2) The Contractor shall, prior to the submission of the Design Data, obtain all required and/or statutory approvals that relate to that submission including, where appropriate, the approval of the concerned government authorities and municipalities and utility undertakings, and demonstrate that all required approvals have been obtained.

(3) All submissions for Temporary and Permanent Works shall be accompanied by two original copies of a `Design Certificate' as set out in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 11 – Design Certificate"** hereto and signed by the Contractor and the Designer.

11.0 DESIGN SUBMISSION PROGRAMME

(1) The Contractor shall prepare the Design submission programme which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the design packages, the Definitive Design Submission and the Good for Construction Drawings submission.

(2) The Design submission programme should be in accordance with the Project Schedule.

(3) The Design Submission Programme shall:

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

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

(c) Make adequate allowance of 28 days for periods of time for review by the Engineer and other review bodies;

(d) Make adequate allowance of 28 days for the Design and development of specialist works;

(e) Include a schedule identifying, describing, cross-referencing and explaining the Design Packages into which the Contractor intends to divide the Definitive Design and Good for Construction Drawings; and

(f) Indicate the Design Interface and Co-ordination periods for each Interfacing Contractor.

(4) The Contractor shall submit the Design Submission Programme to the Engineer within twenty eight (28) days of the Commencement Date, and thereafter up-dated versions thereof at intervals of not more than twenty eight (28) days throughout the Design Phase.

(5) The Construction and Defect Notification Period shall be as indicated in the Conditions of Contract. The Contractor shall be required to plan the various components of work in such a sequence that the entire work is completed within this time frame. Defect Notification Period shall commence after issue of Taking Over Certificate by the Engineer. Before commissioning of the complete rail system, Integrated Testing of the complete rail system will be done, as mentioned in the Contract. Contractor's Design submission programme shall consider all these aspects.

(6) The Contractor shall submit complete set as approved "As-Built" Drawings and certificates for conclusion of any legislative procedures.

12.0 SUBMISSIONS PROGRAMME DURING THE MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING PHASE

(1) The Contractor shall identify submissions required during the Manufacture, Supply, Installation, Testing and Commissioning Phase in accordance with **Part 2 "Employer's Requirement, Section V(A) and V(B)"**.

13.0 CALCULATION

(1) Comprehensive set of calculations relevant to the Construction proposals, Definitive Design and Good for Construction Drawings and any Design change shall be submitted for review with the respective Design packages in soft as well as hard copies.

(2) The Engineer may require the submission of applicable software including in house software programmes/ worksheets developed by the Contractor, computer input and programme logic for its review prior to the acceptance of the computer output.

(3) Calculations to be included as part of the submission herein shall comprise the up-to-date calculations in respect of the Definitive Design, the Good for Construction Drawings and such further calculations which the Contractor has prepared during the production of Working Drawings.

14.0 DOCUMENT REQUIREMENT

(1) Drawings shall be prepared on CAD to the sizes as stipulated in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 7 – Drawings and CAD standards"**.

(2) The titles & numbering scale of drawings shall be as per relevant Indian Railway Manuals/IS Standards as well as above CAD standards to be decided mutually by the Contractor and the Engineer. In all drawings as far as possible only such symbols as are in international use, shall be used.

(3) All designs, legends notes on drawings and schedules of materials shall be in English and shall be prepared in the metrics system.

(4) The Contractor shall submit 4 hard copies and a soft copy of the Definitive Design and drawings including calculations for review by the Engineer. After receipt of the Notice from the Engineer, the Contractor shall submit 4 hard copies and a soft copy of the final Design and drawings for the use of the Engineer.

(5) The approval of drawings shall however be certified on the hard copy only.

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Section V (A). Employer's Requirement: General Specifications

Volume 4 – Design Criteria and Specifications

1.0 GENERAL DESIGN CRITERIA

1.1 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 Design Criteria and standards contained in the technical 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 Design Criteria.

1.2 Operational Requirements

(1) The Permanent Works shall be designed to permit the railway to operate satisfactorily at a maximum speed for freight trains as per PS.

(2) The Contractor's attention is invited to the requirements concerning the role of the Commissioner of Railway Safety (CRS) and Electrical Inspector to Govt. Of India (EIG) as mentioned in **relevant para of bid document**. Sanction of CRS may also be required in terms of Chapter XIII of IRPWM.

(3) It is a requirement that the Indian Railway (IR) remains operational during the construction phase.

1.3 Responsibility for the System Works

(1) The Contractor shall be responsible for detailed design, layout, construction, manufacture, supply, installation, testing and commissioning of the System Works wherever applicable under this Contract.

(2) The Contractor undertakes that the designers shall be available to attend discussions with the Engineer and Employer at all reasonable times during the Contract period.

(3) The Designer shall be the same entity as proposed by the Contractor at the time of pre-qualification, unless otherwise approved by the Employer. The Contractor shall furnish Designer's Warranty in the format provided **in contract forms of Bid Document.**

(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 or rectify such inadequacy, insufficiency, impracticality or unsuitability.

(6) The Contractor shall certify that:-

- The Works have been or will be designed, manufactured, installed and otherwise constructed and to the applicable standards available using proven up-to-date good practice.
- The Works will, when completed, comply with enactments and regulations relevant to the Works.
- The design of the Works have taken or will have taken full account of the effects of the intended manufacturing and installation methods, Temporary Works and Contractor’s equipment.

(7) The Contractor shall also provide an undertaking from the Designer for his Designs for suitability, adequacy, practicality and absolutely meeting the Employer’s Requirements as detailed in **Appendix 11 – Volume 6 Part 2 of Bid Document**. The undertaking shall also state that reasonable skill and care expected from a professionally qualified and competent designer experienced in works of similar nature has been exercised. This shall be applicable for such Designs which may be or have been prepared, developed issued by the Employer, or any of

Contractor's consultants, his sub-Contractors and/or his qualified personnel/persons or cause to have been prepared, developed or issued directly or indirectly by the Contractor.

(8) All the aforesaid shall be applicable notwithstanding the fact that any part of the work may have been inadvertently accepted, passed and paid for by the Engineer or Employer.

1.4 Aesthetics

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

1.5 Safety Considerations

(1) The design of the Permanent Works shall be according to Indian laws and regulations related to Safety Requirements.

(2) Safety 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 as well as in **Part 2 "Employer's Requirement, Section V, Volume 6 Appendix 12 ".** It shall be the overall responsibilities of the Contractor to ensure compliance of Safety aspects at all times conforming to the provisions mentioned in this Bidding document.

1.6 Quality Control

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 as well as in **Part 2 "Employer's Requirement, Section V, Volume 6, Appendix 6 - Quality Assurance"**. It shall be the overall responsibilities of the Contractor to ensure deliverables of quality products at all times conforming to the provisions mentioned in this bidding document.

2.0 DESIGN CRITERIA AND TECHNICAL SPECIFICATION FOR SYSTEM WORKS

Design criteria and the specification for system works shall be as per section V (B) Vol.7, Vol.8 and Vol.9 of Particular specification as under:

SECTION V (B): Particular Specification

Volume 7. Particular Specifications for Signalling works
Volume 8. Particular Specifications for Telecom works
Volume 9. Particular Specifications for Electrical works

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PART 2 Section V(A) Employer's Requirement
General specification
Volume 5

MANUFACTURING, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING

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12.2	Site Laboratories
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20.6	Witnessing by the Employer and the Engineer
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20.9	Fault Log
20.10	Hardware Failure Report
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21.	RECORD
21.1	Records of Tests and Reports
21.2	Drawings produced by the Contractor
21.3	Progress Photographs and Videography
21.4	Records of Wage Rates
22.	DEFECT NOTIFICATION PERIOD
23.	OPERATION & MAINTENANCE SUPPORT PLAN
24.	OPERATION AND MAINTENANCE (O&M) MANUALS
25.	SPARES, SPECIAL TOOLS, TEST EQUIPMENT AND M & P
26.	TRAINING

1.0 CONTRACTOR'S SUPERINTENDENCE

(1) The Contractor shall submit a staff organization plan in accordance with the bidding document along with the details of the qualifications and experience of all proposed staff to the Engineer for his approval. This plan shall be updated and resubmitted whenever there are changes to the staff.

(2) The plan shall show the management structure and state clearly the duties, responsibilities and authority of each staff member.

(3) The contractor shall submit CV of all the concerned personnel of Key Position to the Engineer and seek his approval, whose designation have been mentioned in bid document, before deputing at project site.

2.0 CONTRACTOR'S TEMPORARY WORKS DESIGN

(1) The Contractor shall, prior to commencing the construction of the Temporary Works, submit a certificate to the Engineer signed by him certifying that the Temporary Works have been properly and safely designed and checked and that the Contractor has checked the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.

3.0 THE SITE

3.1 General

(1) Site details furnished by the Employer are those as identified in **Part 4 "Site Data – Reference Documents"**.

3.2 Use of the site

(1) The Site as well as Contractor's Equipment shall not be used by the Contractor for any purposes other than for carrying out the Works, except that, with the consent in writing of the Engineer.

(2) All materials and equipment stored on Site shall be adequately protected against loss or damage due to any cause such as climatic effects, vandalism, shock and vibration, etc. according to the nature of the articles stored and the local Site condition.

3.3 Access to the site

(1) Access to the Railway Envelope by the Contractor shall be in accordance with any procedures, requirements and conditions defined in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 4 - Project Program Requirements"**.

3.4 Clearance of the site

(1) All Temporary Works which are not to remain on the Site after the completion of the Works shall be removed after approval by the Engineer.

(2) The Site shall be cleared and reinstated as stated in the Contract.

4.0 SURVEY

(1) A site survey shall be carried for entire Site to establish its precise alignment and the various levels and features within it.

(2) On or before the Contractor is granted access to a certain portion of the Site, the Contractor shall carry out a survey jointly with the Other Contractors executing works on that portion of the Site. The Contractor shall advise the Engineer of the date of the joint survey at least 1 week in advance of the date.

(3) The survey shall be carried out before the site clearance wherever possible and in any case prior to the commencement of work in any Works Area.

(4) The plan for survey as well as the final report of the survey shall be made by the Contractor and agreed by the Engineer.

5.0 DELETED

6.0 SAFETY MEASURES

(1) The Contractor shall be fully responsible for the safety of the Works, his personnel, subcontractors' personnel, the public and all persons directly or indirectly associated with the Works or on or in the vicinity of the Site.

(2) The Contractor shall treat safety measures as a high priority in all his activities throughout the execution of the Works.

(3) The project site safety requirements have been provided in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 12 - Site Safety Plan"**.

(4) The Contractor shall comply with these requirements provided that the standards set out in the Project Site Safety requirements and Contractor's Site Safety plan shall be regarded as the minimum to be achieved and shall not relieve the Contractor of any of his statutory duties or his responsibilities under the Contract.

(5) The provisions of the Contract regarding safety shall apply to and be binding upon the Contractor for any part of the Works and the persons employed by sub-contractors of any tier.

(6) The Engineer reserves the right to order the immediate removal and replacement of any item of Contractor's Equipment or Temporary Works which, in his opinion, is unsatisfactory for its purpose or is in an unsafe condition.

7.0 CARE OF THE WORKS

7.1 General

(1) Unless otherwise permitted by the Engineer all work shall be carried out in dry conditions.

(2) The Works, including materials for use in the Works, shall be protected from damage due to exposure of weather condition, including ingress of water.

(3) Water on the Site and water entering the Site shall be promptly disposed of.

(4) The methods used for keeping the Works free of water shall be such that settlement of, or damage to, new and existing structures do not occur.

7.2 Protection of the works from weather

(1) Work shall not be carried out in weather conditions that may adversely affect the Works unless proper protection is provided to the satisfaction of the Engineer.

(2) Permanent Works, including materials for such Works, shall be protected from exposures of weather conditions that may adversely affect such Permanent Works or materials.

(3) During construction of the Works storm restraint systems shall be provided where appropriate.

(4) These systems shall ensure the security of the partially completed and on going stages of construction in all weather conditions.

(5) The Contractor at all times shall plan and execute the Works and make all protective arrangements such that the Works can be made safe in the event of storms.

7.3 Protection of the completed work

The finished works shall be protected from any damage that could arise from any activities on the adjacent site/ works, water inflow etc.

8.0 DAMAGE AND INTERFERENCE

(1) Work shall be carried out in such a manner that there is no damage to or interference with:

a) watercourses or drainage systems;

b) utilities especially those pertaining to train operations of existing IR system like working signalling, telecommunication, civil, mechanical, electrical etc. ;

c) structures (including foundations), roads, or other properties;

d) public or private vehicular or pedestrian access;

e) monuments, trees, graves or burial grounds other than to the extent that is necessary for them to be removed or diverted to permit the execution of the Works.

(2) Heritage structures shall not be damaged or disfigured on any account.

(3) The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but which the Contractor considers need to be removed or diverted to enable the Works to be carried out.Such items shall not be removed or diverted until the consent of the Engineer to such removal or diversion has been obtained.

(4) Items which are damaged or interfered with as a result of the Works and items which are removed to enable work to be carried out shall be reinstated to the satisfaction of the Engineer and to at least the same condition as existed before the work started.

(5) Contractor shall use cable route locator to identify cables within the zone of construction, and ensure its safety during construction activity. If required these be relocated/removed as detailed in Para 9.0 below.

(6) Any claims by Utility Agencies due to damage of utilities by the Contractor shall be borne by the Contractor. The contractor shall negotiate a settlement in respect of such claims and indemnify the Engineer and the Employer in respect of all claims, proceedings, damages, costs, charges and expenses in relation thereto.

9.0 UTILITIES

Manner of dealing with all types of utilities are defined in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 1 - Utilities".**

10.0 STRUCTURES, ROADS AND OTHER PROPERTIES

10.1 General

(1) The Contractor shall immediately inform the Engineer of any damage to structures, roads or other properties.

10.2 Access

(1) Alternative access shall be provided to all premises if interference with the existing access, public or private, is necessary to enable the Works to be carried out.

(2) The arrangements for the alternative access shall be as agreed by the Engineer and the concerned agency.

(3) Unless agreed otherwise, the permanent access shall be reinstated as soon as practicable after the work is complete and the alternative access shall be removed immediately as it is no longer required, and the ground surfaces reinstated to the satisfaction of the Engineer. "

(4) Where ever required service road for construction activity, connectivity to the existing road network for the sake of Works has to be made by the Contractor and no extra payment shall be made for the same.

(5) Proper signage and guidance shall be provided for the traffic / users regarding diversions.

10.3 Trees

Manner of dealing with removal of trees from the alignment are defined in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 1 - Utilities"**.

10.4 Removal of graves and other obstructions

If any graves and other obstructions are required to be removed in order to execute the Works, the Contractor shall draw the Engineer's attention to them in good time. Similarly if there are any permanent structures other than those defined in the utilities, para 9.0 above, these shall be brought to the notice of Engineer in good time to allow all necessary arrangements and authorization for such removal. Contractor shall not itself remove them unless the Engineer has given consent. The modalities of removal shall be after mutual discussion between the Contractor and the Engineer.

10.5 Protection of the adjacent structures and works

(1) The Contractor shall take all necessary precautions to protect the structures or works being carried out by others adjacent to and, for the time being, within the Site from the effects of vibrations, undermining and any other earth movements or the diversion of water flow arising from its work.

(2) All operations for the execution of the Works shall be carried out so as not to interfere unnecessarily with the convenience of the public or the access to public or private roads or footpaths or properties owned by the Employer or by any other person.

(3) If during the execution of the Works, the Contractor receives any claim arising out of the execution of the Works in respect of damage to highways or bridges etc., he shall immediately report the facts to the Engineer. The Contractor shall negotiate a settlement in respect of such claims and indemnify the Engineer and the Employer in respect of all claims, proceedings, damages, costs, charges and expenses in relation thereto.

11.0 USE OF ROADS AND FOOTPATHS

11.1 General

(1) Public roads and footpaths on the Site in which the work is not being carried out shall be maintained in a clean and usable condition.

(2) Measures shall be taken to prevent the excavated materials, silt or debris from entering gullies on roads and footpaths; entry of water to the gullies shall not be obstructed.

(3) Surfaced roads on the Site and leading to the Site shall not be used by tracked vehicles unless protection against damage is provided.

(4) Contractor's Equipment and other vehicles leaving the Site shall be loaded in such a manner that the excavated material, mud or debris will not be deposited on roads.

(5) All such loads shall be covered or protected to prevent dust being emitted.

(6) The wheels of all vehicles shall be washed when necessary before leaving the Site to avoid the deposition of mud and debris on the roads.

11.2 Reinstatement of public roads and footpaths

(1) Temporary diversions, pedestrian access and lighting, signing, guarding and traffic control equipment, if any, shall be removed immediately when they are no longer required.

(2) Roads, footpaths and other items affected by temporary traffic arrangements and control shall be reinstated to the same condition as existed before the work started or as permitted by the Engineer immediately after the relevant work is complete or at other times permitted by the Engineer.

(3) The Contractor shall submit his design for the reinstatement to the relevant authorities and obtain their prior approval to carrying out the work.

(4) Reinstatement works shall include:

a) Footpath and Kerbs
b) Road Signage
c) Street Lighting
d) Landscaping
e) Traffic Lights and Control Cable
f) Road painting
g) Telecommunication Tower/Cables

12.0 SITE ESTABLISHMENT

12.1 Engineer’s main site accommodation

(1) The Contractor shall provide, erect, maintain and remove the Site accommodation for the use of the Engineer/Employer, as are set out in **Part 2 “Employer’s Requirement, Section V(A), Volume 6, Appendix 15 - Engineer’s Accommodation”**.

12.2 Site Laboratories

(1) The Contractor shall provide, erect and maintain in a clean, stable and secure condition a laboratory, equipped for the routine testing of concrete, soil and for the storage and curing of concrete cubes or cylinders only. The Lab should have provision of testing/measurement of acidity/BDV of transformer oil, tensile testing, relay testing etc. as per the requirement of work.

(2) This laboratory shall be located at the Contractor's principal work site or at a location agreed to by the Engineer.

12.3 Contractor's site accommodation

12.3.1 General

(1) The Contractor shall provide and maintain its own site accommodation at locations consented to by the Engineer. Offices, sheds, stores, mess rooms, garages, workshops, latrines and other accommodation on the Site shall be maintained in a clean, safe and secure condition.

(2) The Employer will not provide living accommodation for the use of the Contractor or any of his staff or labour employed on the Works.

(3) Living accommodation shall not be established on any land provided to the Contractor by the Employer without prior approval of the Engineer.

12.3.2 Provision of Labour Camp

(1) The Contractor shall, at his own expense, make adequate arrangements for the housing, supply of drinking water and provision of bathrooms, lavatories and urinals, with adequate water supply, for his staff and workmen.

(2) No labour camp shall be allowed at any Work site or at any unauthorised place.

(3) The Contractor at his own cost shall maintain all camp sites in a clean and hygienic condition.

(4) The Contractor shall obey all health and sanitation rules and regulations, and carry out at his cost all health and sanitary measures that may from time to time be prescribed by the local/medical authorities and permit inspection of all health and sanitary arrangements at all times by the Employer, Engineer and the staff of the local municipality or other authorities concerned.

(5) The Contractor shall at his own cost, provide first aid and medical facilities at the labour camp and at work sites on the advice of the medical authority in relation to the strength of the Contractor's staff and workmen, employed directly or through sub-contractors.

(6) The Contractor shall at his own cost, provide the following minimum requirements for fire precautions:

a) Portable Fire Extinguishers.

b) Making and marking exit plan at locations for exit during fires.

(7) The Contractor at his own cost shall provide necessary arrangements for keeping the camp area sufficiently illuminated to avoid accidents to the workers.

(8) The Contractor shall ensure that electrical works are executed by trained electricians and these installations shall be maintained and daily maintenance records be made available for inspection of the Engineer.

(9) Periodic health check- ups may be conducted. These activities may be provided by the Contractor in consultation with State Public Health Department.

(10) It should be ensured by the Contractor that the camp area is cleared of the debris and other wastes and upon completion of construction, the land should be restored back to its original form.

12.3.3 Camp Discipline

(1) The Contractor shall take requisite precautions, and use his best endeavors to prevent any riotous or unlawful behavior by or amongst his workmen, and others, employed directly or through sub-contractors.

(2) These precautions shall be for the preservation of peace and protection of the inhabitants and to secure property in the neighbourhood of the Works.

(3) The sale of alcoholic drinks or other intoxicating drugs or beverages upon the work, in any labour camp, or in any of the buildings, encampments or tenements owned or occupied by, or within the control of, the Contractor or any of his employees directly or through sub-contractors employed on the work, shall be forbidden, and the Contractor shall exercise his influence and authority to secure strict compliance with this condition.

(4) The Contractor shall also ensure that no labour or employees are permitted to work at the Site in an intoxicated state or under the influence of drugs.

(5) The Contractor shall remove from his camp such labour and their families, who refuse protective inoculation and vaccination when called upon to do so by the Engineer on the advice of the medical authority.

(6) Should cholera, plague or any other infectious disease break out, the Contractor shall at his own cost burn the huts, bedding, clothes and other belongings of or used by the infected parties.

(7) The Contractor shall promptly erect new accommodation on healthy sites as required by the Engineer, within the time specified by the Engineer, failing which the work may be done by the Engineer and the cost recovered from the Contractor.

(8) Identification card/ badges incorporating the name and photograph of the person and the name of the direct employer (Contractor, Sub-Contractor, etc.) shall be provided to all staff.

12.3.4 Labour Accommodation

(1) The Contractor shall provide living accommodation for all staff employed by himself or his sub-contractors that is equal to or exceeds the minimum criteria established in the following sub-sections.

(2) The buildings shall be constructed so as to have a minimum life of not less than the length of the Contract.

(3) The roofs shall be water tight and laid with suitable non-flammable materials permissible for residential use under local regulations and for which the consent of the Engineer has been obtained.

(4) Each unit shall have suitable ventilation with all doors, windows and ventilators provided with security leaves and fasteners and back to back units are to be avoided.

(5) The minimum height of each unit shall be 2.10m and each shall have a separate cooking place. The Contractor may provide a common cooking place also.

(6) A suitable number of common toilet/bath shall be provided with separate toilets for ladies.

12.3.5 Water Supply

(1) The Contractor shall provide an adequate supply of water in the Camp.

(2) Where piped water supply is available, supply shall be at stand posts and where the supply is from wells or river storage tanks shall be provided.

(3) The Contractor shall also at his expense make arrangements for the provision and laying of water pipe lines from the existing mains wherever available.

12.3.6 Drainage and Sanitation

(1) The Contractor shall provide efficient arrangements for draining away surface water so as to keep the camp neat and tidy.

(2) Surface water shall be drained away from paths and roads and shall not be allowed to accumulate into ditches or ponds where mosquitoes can breed.

(3) The Contractor shall make arrangements for conservancy and sanitation in the labour camps according to the rules and regulations of the local public health and medical authorities.

(4) The Contractor shall provide a sewage system that is adequate for the number of residents in the camp, and which meets the requirements of the municipal authorities.

(5) The Contractor shall provide lavatories and wash places for the use of its personnel and all persons who will be on the Site.

(6) The size and disposition of lavatories and wash places shall accord with the numbers and dispositions of persons entitled to be on the Site, which may necessitate their location on structures and, where necessary there shall be separate facilities for males and females.

(7) The Contractor shall arrange regular disposal of effluent and sludge in a manner that shall be in accordance with local bye-laws/ regulations.

(8) The Contractor shall be responsible for maintaining all lavatories and wash places on the site in a clean and sanitary condition and for ensuring that they do not pose a nuisance or a health threat.

(9) The Contractor shall also take such steps and make such provisions as may be necessary or directed by the Engineer to ensure that vermin, mosquito breeding etc. are at all times controlled.

12.4 Site utilities and access

(1) The Contractor shall be responsible for providing water, electricity, sewerage and drainage facilities for all site accommodation, structures and buildings in accordance with **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 8 - Temporary Power Supply and Appendix 15 - Engineer's Accommodation"** and all such services that are necessary for satisfactory performance of the Works.

(2) The Contractor shall make all arrangements with and obtain the necessary clearances from the relevant civil and utility authorities for the facilities.

(3) The Contractor shall be responsible for provision of power supply for its works, plants, equipments and the like etc. from State power supply authorities as well as standby generators etc. at this own cost.

(4) The Employer cannot guaranty provision of adequate, continuous power supply however assistance will be given in obtaining the necessary permissions for Site generators and the like.

(5) Access roads and parking areas shall be provided within the Site as required and shall be maintained in a clean, acceptable and stable condition.

(6) For lengths of roadway longer than 100 m and heavy commercial vehicle are to ply, the Contractor shall provide paved surfacing of adequate thickness and quality to the satisfaction the Engineer.

12.5 Transport for the engineer

(1) The Contractor shall provide transport as described in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 15 - Engineer's Accommodation"** for the exclusive use of the Engineer/ Employer for any purpose in connection with the Works.

12.6 Assistance to Engineer/Employer

(1) The Contractor shall provide for the exclusive use and satisfaction of the Engineer at all times during the Contract all such experienced field and office attendants, drivers, messengers, watchmen/security guard instruments etc. as provided in Bid Document.

(2) Chainmen, staff men and office attendants provided by the Contractor shall be bilingual (Hindi/English).

(3) The minimum equipment/apparatus to be available for the exclusive use of the Engineer/Employer are listed in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 15 - Engineer's Accommodation**.

(4) The Contractor shall be solely responsible for all such instruments and apparatus and shall ensure that they are at all times in good repair and adjustment and shall replace items as necessary to meet this requirement.

(5) All equipment other than expendable items shall revert to the Contractor at the end of the Defect Notification Period.

(6) Any operation of the Works that interferes with the checking of works shall be temporarily suspended at the request of the Engineer until the checking is complete.

(7) It may be necessary for chainmen and survey equipment supplied by the Contractor under this Contract to be used occasionally on work outside the Site in connection with the project although not directly associated with construction activities.

(8) The contractor shall make all necessary arrangements to permit this requirement to be implemented.

12.7 Submission of particulars

(1) The following particulars shall be submitted to the Engineer for his consent not more than twenty eight (28) days after the date of commencement of the Works:

a) Drawings showing the formation works and the layout within the Site of the Engineer's accommodation, the Contractor's offices, project signboards, principal access and other major facilities required early in the Contract, together with all service utilities;

b) Drawings showing the layout and the construction details of the Engineer's accommodation; and

c) Drawings showing the details to be included on the project signboards and diversion boards.

(2) Drawings showing location of stores, storage areas, and other major facilities and their access roads/paths shall be submitted to the Engineer for his consent as early as possible but in any case not less than twenty eight (28) days prior to when such facilities are intended to be constructed on the Site.

13.0 SECURITY

(1) The Contractor shall be responsible for the security of the Site for the full time the Site is in its possession, except for the specific case of the Railway Envelope after handover to the Employer.

(2) The Contractor shall maintain all site boundary fences in first class condition, and shall so arrange site boundary fences at all access drainage points of work areas that it's use of such access points etc., are not restricted by the system or method of achieving the required security measures.

(3) Notices shall be displayed at intervals around the Site to warn the public of the dangers of entering the Site.

(4) During the progress of the Works the Contractor shall maintain such additional security patrols over the areas of the Works as may be necessary to protect its own and its sub-contractor's work and equipment and shall co-ordinate and plan the security of both the work under this Contract and the work of others having access to and across the Site and the Works.

(5) The Contractor shall liaise with the sub-contractors and the contractors responsible for the adjacent and other interfacing contracts and ensure that co-ordinated security procedures are operated, in particular in respect of vehicles permitted to pass through the Site and/or the adjacent sites in the later periods of the Contract.

14.0 PRECAUTIONS WHILE WORKING IN CLOSE PROXIMITY OF EXISTING INDIAN RAILWAY TRACK

14.1 General

(1) Prior to the commencement of construction operations, the Contractor shall obtain all necessary clearance from the concerned authorities.

(2) 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.

14.2 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.

14.2.1 Works being done within 3.5 meters from centre of track.

(i) 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 be taken. This includes even occasional plying of vehicles/ machineries for short durations.

14.2.2 Works being done between 3.5 meters and 6 meters from centre of track.

Following precautions 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.

(i) 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.

(ii) In case vehicles have to ply or machineries have to work within this zone, railway's and contractor's supervisors be positioned as shown in sketch D except for the following:

Instead of a Railway supervisor it would be a responsible and trained staff of the Contractor as mentioned in para 14.1.2.2 (ii) above.

(iii) Additional trained staff of the Contractor, as mentioned in para 14.1.2.2 (ii) above, shall be posted where turning of vehicles is required during working. Location for reversing vehicles should be nominated and it should be selected in such a way that there is no danger to running trains at such a location. Such trained staff of the Contractor should be available with hand flags 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.

(iv) 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 14.1.2.2 (ii) above.

(v) In addition to look out men, caution order needs to be issued to trains and speed restrictions imposed wherever considered necessary through Employer.

(vi) Arrangements should be made to protect the track in case of emergency at work site.

(vii) All temporary arrangements required during execution should be done in a manner that moving dimension is not fringed.

(viii) 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.

(ix) Any materials unloaded or shifted along the track should be kept clear of moving dimensions and stacked at a specified distance from running track.

(x) 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.

(xi) 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.

(xii) 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.

(xiii) 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:

a) Any possibility exists for machinery/vehicle after toppling/due to loss of control come over track or infringe it.

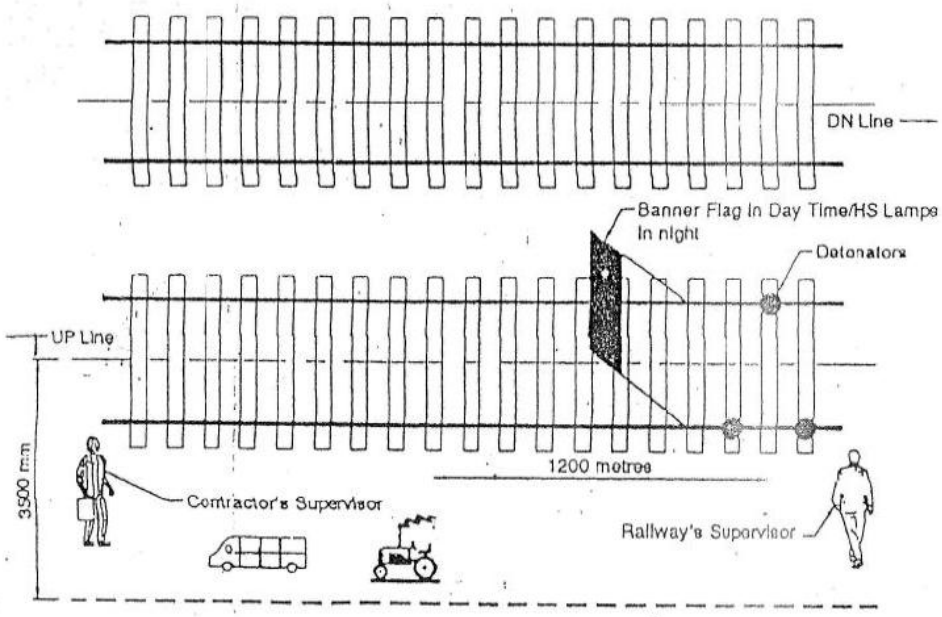
b) Chance of machineries/vehicles to come within 3.5 meters from track centre though working beyond it.

14.2.3 Works being done beyond 6 meters from centre of IR track.

SAFTY/PROTECTION ARRANGEMENT SKETCHES

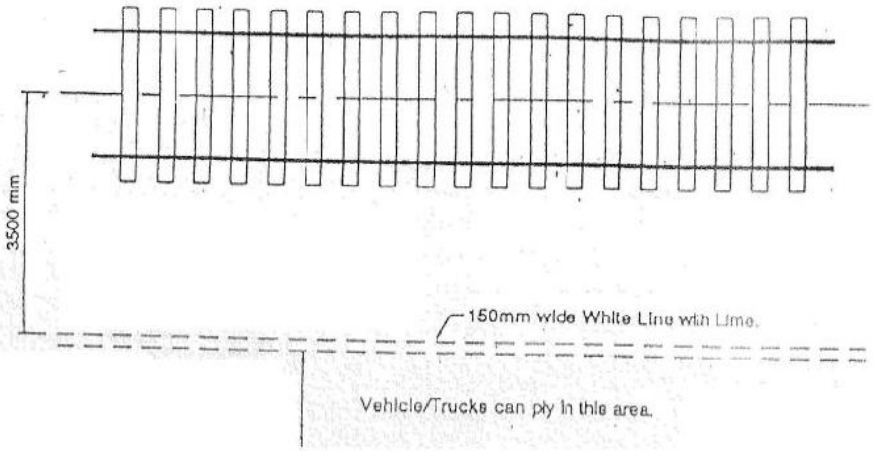
SKETCH - A

Plying of Vehicles/Machinery within 3.5 Mts. from centre of track.



SKETCH - B

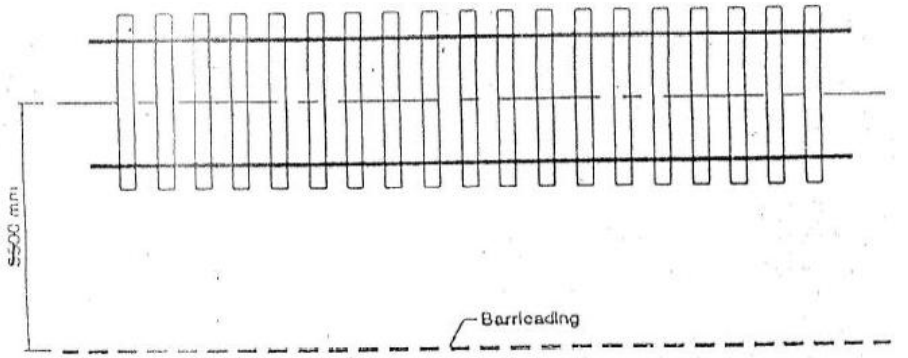
Marking of White Line with Lime.

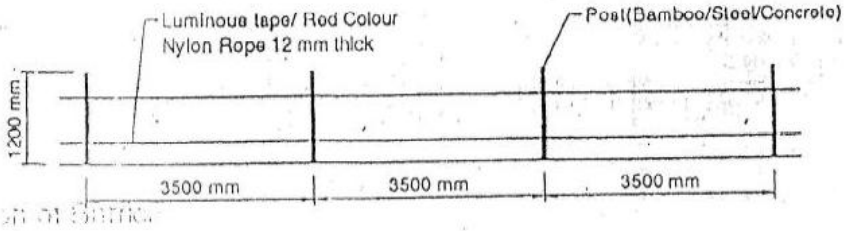


No precautions are needed except in cuttings or where the work can affect train running in any way.

SKETCH - C

Provision of Barricading.

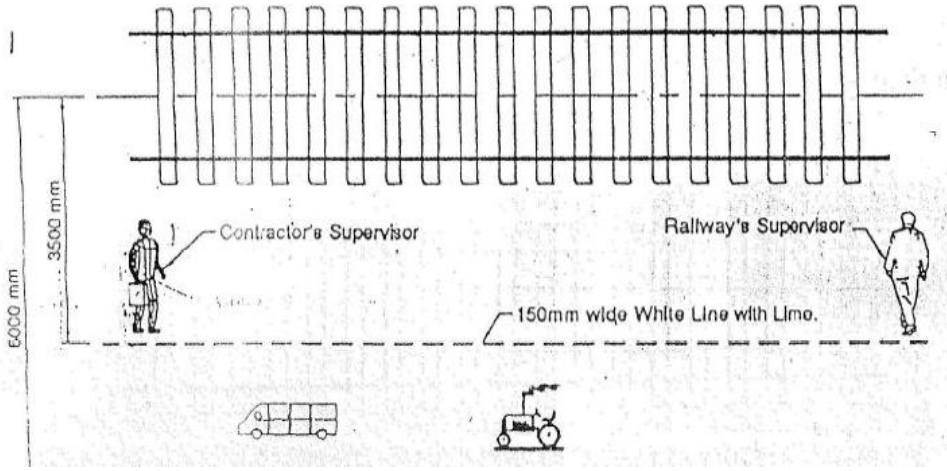




Elevation of Barricading

SKETCH - D

Plying of Vehicles/Machinery between 3.5 Mts. to 6.0 Mts. from centre of track.



15.0 CONSTRUCTION-SYSTEM WORKS

15.1 General

(1) The Contractor shall co-ordinate during the planning and execution of works with designated Contractors for other related activities e.g. track, Civil work etc. for construction of the complete system of Dedicated Freight Corridor.

(2) The installation of all machinery and equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor and to the satisfaction of the Engineer.

(3) The Contractor shall, prior to starting any installation and construction work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

(4) The Contractor shall require access to information as well as to various locations at stations/depots/tracks/bridges etc. of Indian Railways in stages.

a) A written request regarding access to any information shall be given by the Contractor to the engineer sufficiently in advance for arranging the same as available.

b) The Contractor shall plan out in consultation with other designated contractors the number and location of the access points and shall submit the same to the Engineer at least two months in advance

(5) The construction and installation work pertaining to this contract shall include, but not be limited to the following:

a) Survey on site, review and confirm the technical requirements shown in this contract and the Reference Drawings.

b) Finalization of the manufacturing/construction and installation program.

c) Production of the calculation sheets and manufacturing/construction drawings/specifications for Site works and installation.

d) Construction and Installation in accordance with the finalized construction Drawings.

e) Co-ordination with various designated contractors.

f) Obtaining clearances from various stakeholders and authorities.

g) Submission of the manufacturing/construction and installation reports and records.

h) Testing and commissioning as per finalized protocol and programme.

i) Production of As Built Drawings, documents, calculation sheets and records.

15.2 Temporary Works

(1) Any temporary arrangements and works, as required to carry out the SYSTEM work such as temporary depots to handle and stack the materials, temporary stores, offices, fencings etc. shall be done by the Contractor at his own cost.

(2) The programme and scheme and design of all such temporary works with full justification of the requirement and the approximate period for which these will be needed, shall be submitted to the Engineer for prior approval.

(3) Construction Depot

a) The Contractor will be required to establish at least one temporary construction depot at the site of works where materials and equipments etc. could be stored for the construction purposes. The location of temporary construction depot shall be got approved by the Engineer.

b) In case spare land is available with the Employer the same can be handed over to the Contractor free of cost for the purpose of establishing temporary construction depot(s). However, whenever Employer requires this portion of land back, the same shall be handed over to the Employer with a month's notice at no extra cost/compensation to the Contractor.

(4) All temporary works shall be removed on completion of permanent works, or as directed by the Engineer.

16.0 MANUFACTURE, SUPPLY, INSTALLATION, TESTING & COMMISSIONING

16.1 General

(1) These Employer's 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 in the Permanent works.

(2) These requirements relate to manufacturing, procurement and delivery of component fittings, conductors, equipment structures, plant and manufactured items and the requirements for installation, testing and commissioning, and associated activities (manuals, spares, training etc).

(3) The Contractor shall submit a comprehensive Test Plan &Programme for the project to the Engineer for his consent.

(4) The Contractor shall inform the Engineer of the installation of the manufactured items including manufacturing plan and schedule of the manufactured items at the manufacturer's facilities.

(5) The Engineer or Employer's representative shall be offered to participate for the tests particularly the Type Tests to be performed on the equipment and/or fittings or conductors and/or batches materials to be examined before the material is supplied to the Site.

(6) The Contractor shall organize those participations as required by the Engineer.

(7) The materials delivered to the Site and offered for Inspection shall be manufactured normally not earlier than one (1) year and their guarantee period shall cover the Defects Notification Period. However the specified period of Manufacturer's Warranty shall commence from the date of commissioning of the Work and all the manufacturer's Warranties shall be in the name of Employer.

(8) All materials shall be as per the Specifications furnished and as consented by the Engineer.

(9) Manufacturing and testing of various components, fittings, clamps, jumpers, droppers, other fittings, components and equipment shall be as per relevant RDSO and other Specifications, as accepted by the Employer.

(10) The Contractor's Manufacturing Management and Quality Assurance Plans shall be submitted to the Engineer for consent within 60 days after the Commencement Date as a preliminary plan and as part of the Technical Design for the final Plans for each plant, equipment and manufactured item

16.2 Procurement and subcontract management

(1) The Contractor shall prepare and implement a Quality Assurance plan based on ISO 9001 standards addressing each element therein for the management systems and procedures for materials procurement and sub-contracting, sufficient to assure technical, administrative, quality and contractual controls consistent with those of this contract.

(2) The Contractor's management system shall be auditable for material sources, lot numbers, serialiased equipment, etc., sub-contract amendments shall be employed whenever contractual changes are made either bi-laterally or unilaterally by the parties involved.

(3) Registration of the Contractor's organisation, or subcontractors or sub-consultants is not required for this Project but the Project Quality Management Plan, as submitted, shall meet the intent of the ISO 9001 requirement in that there is a comprehensive and documented approach to achieving the project quality requirements.

16.3 Manufacturing and production management

(1) The Contractor's manufacturing and production management system shall encompass all aspects of receiving, raw material and components processing, fabrication, assembly, test and all points of in-process inspections. The Contractor shall submit manufacturing data as part of the Manufacturing Management Plan, and this shall contain:

a) Brief description of all inspection hold points and test points, and a correlation with the Programme Schedule;

b) List of all sub-contractors; and

c) Shipping and delivery schedule of each item of equipment to match the installation plan.

16.4 Testing

(1) The Contractor shall provide a comprehensive testing programme that shall include the complete equipment, their subsystems, components and material to assure conformance with the Specifications.

(2) The testing programme shall be approved by the Engineer.

(3) The purpose of the comprehensive testing programme shall be to:

a) substantiate design where specified under the Contract and performance characteristics;

b) ensure operational compatibility;

c) complete equipment verification and acceptance requirements; and

(4) Testing shall comply with the requirements contained in Employer's Requirements.

16.5 Inspection by the engineer and employer's representative

(1) The Contractor shall prepare an Inspection Programme for agreement by the Engineer which shall provide the opportunity for the Engineer and/or the Employer's representative to have access at key points during the production and manufacture of Materials and Plant to examine, inspect, measure, and test the materials and workmanship, and check progress, as necessary.

(2) Where such an inspection takes place on completion of production or manufacture this may be combined with the Testing Programme.

16.6 Quality assurance and controls

(1) The Contractor shall be responsible for quality control including all testing, checking and measurement.

(2) The Employer or the Engineer may carryout independent quality control tests through his own personnel or other agencies.

(3) The Contractor shall provide all necessary assistance and cooperation to the Employer and the Engineer for carrying out the inspections and tests .

(4) The Contractor's management systems shall emphasise quality assurance and controls and shall be based on ISO 9001 standards.

(5) The programme shall ensure an acceptable level of quality for the equipment supplied.

(6) The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of the Contractor's organisation, and shall be evidenced by:

a) Producible and inspectable designs;

b) Procurement and job performance specifications;

c) Procedures for transmission of information and data to sub-contractors and for ensuring their compliance;

d) Testing to ensure repetitive product conformity to design requirements; and

e) Total programme of surveillance and verification of physical performance and configuration accountability.

(7) Adequate records shall be kept by the Contractor to provide evidence of quality and accountability, these records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant material; and other quality control requirements.

(8) Inspecting and testing records shall be in ISO format and, as a minimum indicate the nature of the observations made, and the number and types of deficiencies found and action proposed to correct deficiencies.

(9) Records for monitoring work performance and for inspecting and testing shall indicate the correction of deficiencies.

(10) The Contractor shall submit to the Engineer a request for a "Notice of No Objection to Supply" for all manufactured items along with all the relevant manufacturer's test certificates and inspection certificates prior to shipping/transporting. This shall be accompanied by a Verification Submission which shall provide sufficient documentary demonstration of the suitability of the Plant & Equipment and manufactured items for supply.

(11) Such Notice may be issued by the Engineer in respect of the completion of Manufacturing of a major and distinctive element comprising part of the Permanent Works.

(12) However, supply shall not be commenced until the original copies of the appropriate Submission have been endorsed:

a) by the Contractor as "Good for Supply";

b) by the Engineer that he has no objections to the supply.

(13) In addition, the Contractor shall comply with **Part 2, "Employer's Requirements, Section V(A) and V(B)** and the "Quality Management" requirements stated elsewhere in this Volume.

(14) The inspection is to be conducted by the contractor and witnessed by the Engineer and/or the Employer representative. The Employer may depute its representative or nominate any other independent inspection agency such as RITES, (in addition or as replacement) for supervising, monitoring and inspection of raw/final material and manufacturing process at the factory.

17.0. MATERIALS AND EQUIPMENT

(1) Materials and goods for inclusion in the Permanent Works shall be new. Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of material delivered to the Site.

(2) Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer. A letter from the supplier stating that the certificates relate to the material delivered to the Site shall be submitted with the certificates.

(3) Parts of materials which are to be assembled on the Site shall be marked to identify the different parts.

(4) In addition to any special provisions in the Contract for the sampling and testing of materials, the Contractor shall submit samples of all materials and goods which it propose to use or employ in or for the Works. Such samples, if having been reviewed without objection, shall be retained by the Engineer and shall not be returned to the Contractor or used in the Permanent Works unless reviewed by the Engineer. No materials or goods of which samples have been submitted shall be used in the Works unless and until the Engineer shall have reviewed such samples without objection.

(5) The samples shall be used as a mean of comparison which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples which have received consent.

(6) The Employer's Representative may reject any materials or goods which in his opinion are inferior to the samples. Given a Notice, the Contractor shall promptly remove such materials and goods from the Site.

(7) Notice of place of manufacture and /or source of supply

The Contractor shall notify the Engineer of the places of manufacture and/or the source of supply of all goods and materials to be incorporated into the Permanent Works. The Contractor shall give reasonable notice (which shall not in any event be less than 2 8 days) to

the Engineer be for the start of any manufacturing and/or the supply of goods and materials.

(8) Certificates for Manufactured Goods or Materials

The Contractor shall obtain certificates for each batch of goods and materials incorporated into the Permanent Works. Each certificate shall certify that the materials comply with the requirements of the Contract and shall include all reports of inspections and/or tests carried out at the place of manufacture.

18.0 MANUFACTURE & SUPPLY VERIFICATION SUBMISSION

(1) On completion of the manufacture of Plant, the production of Materials, and the associated testing, and Quality Assurance and Control processes, a 'Manufacture & Supply' Verification Submission shall be prepared which shall provide sufficient documentary demonstration of the suitability of the Plant and Materials for subsequent installation, this shall include, but not be limited to:

a) confirmation that the manufactured items of Plant or Materials produced fully comply with the Drawings/Specifications relating to manufacture;

b) confirmation that all relevant testing has been successfully completed, with supporting completed test documentation;

c) confirmation that all Quality Assurance and Controls processes have been completed with the required level of satisfaction, with supporting completed Quality Assurance documentation;

d) Confirmation that the Plant and/or Materials have not suffered damage or deterioration during transit to site.

(2) The Contractor shall not commence the subsequent Installation phase until he has received a Notice of no Objection from the Engineer in respect of the Manufacture & Supply Verification Submission.

19.0 INSTALLATION

19.1 Installation Plan and Programme

(1) The Installation Plan shall show how the Contractor proposes to organise and carry out the Installation and complete the whole of the Works by the given Key Dates.

(2) The Contractor shall submit the Plan for the review of the Engineer 30 days prior to the start of Installation on Site.

19.2 Installation Method Statement

(1) Installation Method Statements shall be submitted to the Engineer for review at least 28 days prior to the installation activity commencing On-Site, this shall show in particular the loadings and modes and delivery routes of the items of equipment.

(2) Prior to proceeding with installation, the Contractor shall submit for the Engineer's consent five 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.

(3) The manufacturer's rigging or erection instructions shall be carefully followed.

(4) The Contractor shall ensure that the installation of all supports, gaskets, hardware, etc., is accomplished so as to assure safe, accurate and trouble-free installation. The Installation for major items shall be undertaken preferably in the presence of the Manufacture's Field Service Representative.

(5) Upon noticing or being advised of any inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall notify his acknowledgement to the Employer and correct such errors within two weeks.

(6) Equipment that is improperly installed shall be removed, checked / tested and reinstalled. Any damage caused due to improper installation and removal shall be rectified before reinstallation and removal shall be rectified before reinstalling at no extra cost.

(7) Contractor shall submit the Installation Testing Plan (ITP) for major items for approval by Engineer and installation and testing shall be carried out according to approved ITP.

19.3 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 minimum information as follows:

a) asset details;

b) failure history;

c) date installed; and

d) date(s) tested.

(3) All equipment and software shall have a unique identification number that can be identified electronically and manually.

(4) The identification label shall be permanently attached in such a way that it shall not become detached or illegible during the lifetime of the system from any cause including wear and tear, environmental effects (such as rain, direct sunlight, etc.) or any other influence. Preferences hall be given to emboss or engraved metallic labels mechanically fastened by riveting or similar means to the item to which they refer. The Identification shall be placed so as to be easily read for the accessible face.

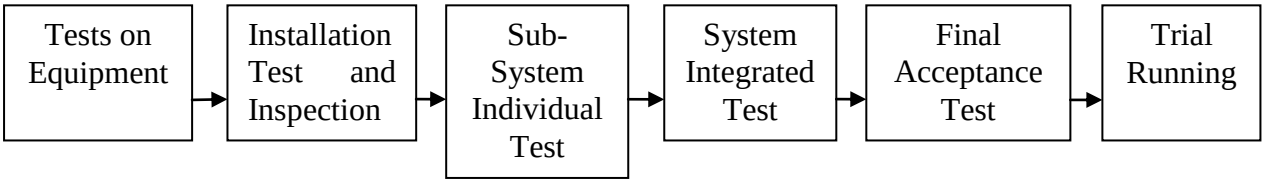
20.0 TESTING AND COMMISSIONING

20.1 General

(1) The Contractor shall provide and perform all forms of testing procedures applicable to the Works and various components including all necessary factory, site and acceptance tests required therein and for the interfacing of the Works with the other Contract works. Until the time the Works are taken over by the Employer, Contractor shall maintain the same in a manner so as to continuously meet the acceptance criteria for all aspects, as per the requirements mentioned in the **Employer's Requirement, Part 2 of Bid Document.**

(2) Contractor shall make a consolidated list of all the tests required for Testing and commissioning along with the method statement detailing testing procedures and applicable codes/ manuals and submit the same to the Engineer for enabling a joint program of testing. 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.

(3) The commissioning activity shall include a period of Integrated Testing of System followed by a period of trial running attended by the CRS or other authorized official and for staff training and familiarization and timetable proving purposes. Accordingly a typical test sequence may be as shown below:-



(3) The Engineer, the Employer's Personnel and authorized agencies shall at all reasonable times:

(a) have full access to all parts of the Site and to all places from which natural Materials are being obtained, and

(b) During production, manufacture and construction (at the Site and elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of Materials.

(c) The Contractor shall give them full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility. They shall be provided the facilities for monitoring all tests and have access to all testing records.

(5) Ample time shall be allowed within the testing programmes for necessary alterations to equipment, systems and designs to be undertaken, together with re-testing prior to final commissioning.

(6) The testing procedures shall be submitted by the Contractor and amended, if required subsequently 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.

(7) The Contractor is reminded 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 programmes of all the contractors and all associated with the Traction Power Energisation Programme.

(8) All costs associated with the Testing shall be borne by the Contractor. However this shall not include allowances for hotel and expenses for the person witnessing/ certifying the test on behalf of the engineer/ Employer representative. The Contractor shall also bear any expenses incurred due to resetting/re-testing caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

(9) The contractor shall bear all expenses including hotel/travel/cost of witnessing if any incurred due to retesting caused by defects or failure of equipment to meet the requirements of the contract in the first instance.

(10) In the event of any tests being performed in countries other than India, the Contractor shall give at least 60 days' notice to the Engineer / Employer for witnessing the tests.

(11) Unless agreed 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.

(12) The Employer and the Engineer will bear their own cost for attendance at witnessed inspections or tests (other than re-test) scheduled in accordance with agreed Test plan and subject to notice in accordance to the specification. Further details are given in Particular specification.

(13) All testing equipment shall carry an appropriate and valid calibration labels

(14) Examination of Works before covering up: No work or part of work shall be covered up or put out of view, without the prior approval of the Engineer or the Engineer's Representative. The Contractor shall uncover any part or parts of the Works, or make openings in or through the same, as the Engineer may from time to time direct, and shall reinstate and make good such part or parts, to the satisfaction of the Engineer.

(15) If any defect or damage requires immediate attention from a safety, environment or operational aspect, the Engineer has the authority to proceed with the rectification in any manner suitable and deduct the cost from the next due interim payment.

(16) Testing shall be undertaken generally in accordance with the requirements contained within relevant clauses of the latest version of standards relating to the particular equipment concerned, together with other relevant standards which relate specifically to testing.

(17) Inspection and Testing Philosophy.

(a) The inspection of various items shall be carried out by the agencies in the manner as approved by the Engineer.

(b) All field tests shall be witnessed by authorized representative of the Engineer / Employer & recorded. An appropriate format for Test Schedules and Procedures including the details

of testing equipment shall be submitted to the Engineer for approval. All tools & instruments for carrying out the tests shall be arranged by the Contractor to the satisfaction of the Engineer. Test results will be witnessed and signed by the Contractor and the Engineer.

(c) Test Certificates and Reports: The Contractor shall submit manufacturer's type and routine test certificates and reports for each equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, 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.

20.2 Manufacturing Test Plan

20.2.1 The Manufacturing Test Plan is the Contractor's plan for carrying out the necessary procedures to ensure that the items presented for acceptance by the Employer and Engineer are in compliance with the requirements of the Specification.

20.2.2 During the process of procurement and manufacture of the system components the Contractor shall undertake such testing and inspection as is required by the Quality Plan.

20.2.3 The Employer's Personnel will not become involved in the Contractor's Manufacturing Tests except in respect of :

- Type tests ;and
- Factory Acceptance Test

20.2.4 Before shipment of any items to Site the Contractor shall present the items for the first stage of Acceptance according to the Commissioning Plan.

20.2.5 The Contractor shall be wholly responsible for all the inspection of items to be incorporated into the system as a whole.

20.2.6 Type Tests

(1) Type tests will not be required in those cases where the Contractor can produce certified evidence within last 5 years, that the required type tests have been performed successfully on identical equipment or equipment which is, for practical test purposes, of identical design, made using identical raw materials/components, made using identical software version under similar manufacturing conditions in the factory where the equipment offered is to be manufactured, provided the type test(s) have been carried out and /witnessed by reputed agencies. The final decision regarding applicability and acceptance of the type test certificate produced shall rest with Engineer.

(2) For each test, the Engineer will determine whether the item under test has passed or failed. In general, the test will be considered to have failed if either:

- The result of the test is not in accordance with the expected result described in the test procedure, or
- The result of the test is in accordance with the expected result described in the test procedure, but some other unexpected or unexplained event occurred which the Engineer considers to be a fault.

(3) If during Type Tests, any failure occurs or the equipment design is changed, it shall be reported to the Engineer who may, at his discretion, require repetition of the previous tests at the Contractor's cost.

20.2.7 Factory Acceptance Test (FAT)

(1) Before shipment all manufactured items or systems shall undergo FAT in accordance with the requirements of the PS.

(2) Factory Acceptance Test (FAT) or works test

(a) Works Tests shall include but not be limited to:

- Physical inspection;
- Dimensional test
- Calibration;
- Output check;
- Operational performance;
- Full Load test;
- Flash-over test;
- Insulation test;
- Soak test; and
- Any other test required as per relevant standards or codes.

(b) A Factory Test Plan shall be submitted for the Engineer's review within three months from the Date for Commencement of the Works.

(c) All materials, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subject to testing and certification. Notification of these Tests shall be submitted to the Engineer thirty (30) days in advance of carrying out any Test, the Engineer will then determine which, if any, items that may be accepted based on previous supply or experience.

(d) At least 15 days prior to each FAT the latest drawings, inspection and test procedures, specifications and quality documentation required for adequate inspection of the equipment under inspection shall be submitted to the Engineer. The drawings shall be completed to the lowest level replaceable unit.

(e) The Contractor shall ensure that he and his subcontractors are prepared for all inspections/test. The Contractor shall not schedule more than one FAT on the same day without prior notice of No Objection by the Engineer.

(f) The FAT shall demonstrate that each equipment/sub-system meet its functional specification.

(g) 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 specification by carrying out the FAT.

(h) Where processor based equipment is to be used, the Works Tests shall include also verification of software used in this application.

(i) FAT shall be performed by the contractor and the Engineer/ the Employer shall attend FAT on all major equipment items or sub-systems identified by the Engineer. The Employer may authorize other agency like RDSO, RITES for FAT for inspection on behalf of the Employer.

20.3 Commissioning Plan

(1) The Commissioning Plan is the Employer and the Engineer tool for managing and co-ordinating the Testing, Commissioning, Training and Service Trial activities. The Commissioning Plan will be divided into the following sub-plans:

(i) Factory Testing Plan

(ii) On-Site Testing and Commissioning Plan

(2) Testing and Commissioning Phases

Testing and Commissioning activities shall be undertaken in the following phases:

(i) Factory Acceptance Test

(ii) Installation Tests;

(iii) Partial Acceptance Tests;

(iv) System Acceptance Tests;

(v) Integrated Testing & Commissioning; and

vi) Service Trial.

Note: Items (iii), (iv), (v) and (vi) as required by the PS constitute the Tests on Completion referred to in the GCC.

20.4 On-Site Testing and Commissioning Plan

20.4.1 The Contractor shall prepare and submit for a Notice by the Engineer the Contractor's On-Site Testing and Commissioning Plan detailing and explaining how the Contractor will plan, perform and document all tests and inspections that will be conducted to verify and validate the Works on Site. The On-Site Testing and Commissioning Plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

20.4.2 The On-Site Testing and Commissioning Plan shall contain, but not be limited to, the following topics:

(i) The Contractor's strategy for testing and commissioning all constituent parts of the Works and how this relates to the sequence of construction and installation;

(ii) The interdependency and interaction with other Contractors and their commissioning programmes;

(iii) The type and extent of testing and commissioning to be undertaken and the parts of the Works to be proven by that testing;

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

(v) The plan for the production and submission of the testing and commissioning procedures to the Employer's Representative for review including the submission of the testing and commissioning reports and records; and

(vi) The On-Site Testing and Commissioning Plan shall be organised and submitted in the stages

20.4.3 Installation Tests

a) The Installation Tests is defined as being the final stage of assembly/installation before the start of commissioning itself. The Installation Tests are to be performed by the Contractor under the Contract and may be witnessed by the Employer or the Engineer. During this phase, the Contractor shall perform static testing of components and/or systems in preparation for Partial Acceptance Testing.

b) The particular requirements for Installation Tests are prescribed in the PS. Where performance across interfaces to other Contractors or to other parties is required to be verified, the Contractor shall liaise with the interfacing party to co-ordinate the test procedures and programme.

c) The Contractor shall submit to the Engineer an Installation Test Plan including a comprehensive schedule of tests as required by the Particular Specification giving full details and procedures for each test to be carried out under the Contract and including the pass / fail criteria i.e. the standards or limits to be achieved.

d) Prerequisites for Installation:

i. Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and ensure for their dimensional accuracy.

ii. Designs for the Sections under test shall be completed and submitted to the Engineer for review prior to Installation.

e) The Contractor shall prepare three copies of a test report immediately after the completion of each test whether or not witnessed by the Employer and/or the Engineer. If the Employer and/ or the Engineer has witnessed the test, he will counter sign the report to indicate his Notice of No Objection to the information and conclusions (i.e. whether or not the equipment being tested has passed satisfactorily) contained therein. If the Employer and/or the Engineer has not witnessed the test (i.e. if a written waiver has been granted), the Contractor shall forward three copies of the test report without delay to the Engineer.

f) The Engineer will counter sign the report to indicate his Notice to the information and conclusions (i.e. whether or not the equipment being tested has passed or failed) and return one copy to the Contractor. Where the results of the test do not meet the requirements of the Specification, the Employer or the Engineer may call for are - test at the Contractor's own expenses.

g) Test equipment and instrumentation shall be subject to calibration testing within a properly controlled calibration scheme, and signed calibration certificates shall be supplied to the Engineer induplicate. Such calibration checks shall be undertaken prior to testing and, if required by the Employer or the Engineer, shall be repeated afterwards.

20.4.4 Partial Acceptance Tests (PAT)

(1) Partial Acceptance Tests are defined as the performance of functional tests of sections, areas, or stages of a system. The Partial Acceptance Tests are part of the Tests and Inspection to be performed by the Contractor under the Contract in order to achieve the Employers Taking Over of the Works. During this phase, an energy source shall be introduced to enable functional testing to be performed. On satisfactory completion of the Partial Acceptance Tests, the tested items will be considered available for Systems Acceptance Testing.

(2) The particular requirements for Partial Acceptance Tests are prescribed in the PS.

(3) The Contractor shall submit to the Engineer a comprehensive Partial Acceptance Tests Plan including all requirements detailed in the PS. The plan shall be submitted on a logical section-by-section basis, using a "top-down" approach describing the testing and commissioning strategies and processes clearly showing how these serve to provide the full verification of the systems and equipment.

(4) The Partial Acceptance Tests Plan shall identify a comprehensive list of specifications, standards, method statements, procedures, pass/fail criteria, sample records, resources to be made available, drawings and records to be submitted to the Engineer, and a programme showing the dates for testing and for submission of each test procedure.

(5) Test procedures shall be carefully planned to ensure that the work can be executed in the time available. If the available time is restricted, this planning shall include contingency plans to be implemented if testing proceeds slower than anticipated or if defects are discovered that necessitate rectification and subsequent repeat testing, etc.

(6) If any working equipment is relocated or altered by the Contractor during the execution of the Works, thorough re-testing shall be performed to verify that the equipment remains fully functional and operates safely according to its specification. The testing to be performed shall be no less rigorous than the procedures used for the original testing and commissioning of the equipment.

(7) The Contractor shall submit to the Engineer by the date laid down in the Particular Specification, or if no date is given, no later than two months before the commencement of the Testing & commissioning work, three copies of its proposed Partial Acceptance Tests sample records. The records shall be appropriately sub-divided to make provision for the various parts of the systems and equipment covered by the Contract and shall cover all tests (mechanical, electrical or otherwise), positive identification of equipment, assemblies and sub-assemblies by serial number, drawing and specification reference numbers (and issue reference) and any other data to be given Notice by the Engineer during the course of commissioning.

(8) The Contractor shall during the execution of the Works prepare such reports and records of design, manufacture, installation, erection and testing as may be required in order that any relevant licenses or approvals (including any statutory approvals) may be issued or granted. Such records shall be adequate to enable the system or its respective part to be commissioned and to meet the requirements of the licensing authority or statutory body.

(9) Immediately following the successful Partial Acceptance Testing of the system or any constituent part, the Contractor shall complete the appropriate Partial Acceptance Tests records in the agreed format and submit three signed copies to the Engineer.

20.4.5 System Acceptance Tests (SAT)

(1) System Acceptance Tests are defined as the tests undertaken to demonstrate that the Works in its entirety is capable of functioning in accordance with the specified requirements in the Contract in all respects. The System Acceptance Tests are part of the Tests on Completion to be performed by the Contractor under the Contract in order to achieve Employer's Taking Over of the Works. The System Acceptance Tests may commence before remote operations capability (if any) is fully functional, however, the system must be satisfactorily tested remotely (if specified to have such capability) before the System Acceptance Tests can be considered to be completed. On satisfactory completion of the System Acceptance Tests, the tested items will be considered available for Integrated Testing & Commissioning.

(2) The particular requirements for System Acceptance Tests are prescribed in the PS.

(3) The Contractor shall submit to the Engineer a comprehensive System Acceptance Tests Plan including all requirements detailed in the PS. The plan shall be submitted on a section by section basis to demonstrate how the System Acceptance Tests are to be carried out. The plan shall adopt a top down approach and describe the system completion strategy and process.

(4) System Acceptance Tests shall comprise comprehensive testing of the assembled installation to ensure that it operates in accordance with the requirements of the PS.

(5) Prerequisites and requirements for SAT to be satisfied before the commencement of the System Acceptance Tests (SAT) shall be as follows:

i. All documentation for the System Safety Report shall be submitted to the Engineer for review;

ii. All PAT shall be completed and test records submitted to the Engineer for review;

iii. Employer's Personnel shall be given a training course in the System as defined in the Section on Training herein;

iv. The SAT Plan shall be submitted to the Engineer for review at least one hundred and twenty (120) days before the commencement of the SAT.

(6) The tests shall include, but not be limited to, the following:

a. Tests of all functional and performance requirements for the system;

b. Tests of behavior under failure conditions, e.g. functioning of fail safe mechanisms, changeover to redundant hardware; initiation of re-configuration functions or reverse modes of operation; and recovery of the

equipment and system from failure.

(7) The System Acceptance Test Plan shall identify a comprehensive list of specifications, standards, method statements, procedures, pass / fail criteria, sample records, resources to be made available, drawings and records to be submitted to the Engineer for a Notice and programme showing the dates for testing and for submission of each test procedure.

(8) Test procedures shall be carefully planned to ensure that the work can be executed in the time available. If the available time is restricted, this planning shall include contingency plans to be implemented if testing proceeds slower than anticipated or if defects are discovered that necessitate rectification and subsequent repeat testing, etc.

(9) Immediately following the successful acceptance testing of the system, the Contractor shall complete the appropriate Testing & commissioning records in the agreed format and submit three signed copies to the Engineer.

20.4.6 Integrated Testing & Commissioning

(1) Integrated Testing & Commissioning are defined as the final tests to be undertaken before the commencement of Service Trial. The Integrated Testing & Commissioning are part of the Tests on Completion to be performed by the Contractor under the Contract in order to achieve Employer's Taking Over of the Works. The Integrated Testing & Commissioning shall demonstrate the full compatibility between all interfacing systems. On satisfactory completion of the Integrated Testing & Commissioning, the tested items will be considered available for Service Trial.

(2) The particular requirements for Integrated Testing & Commissioning are prescribed in PS

(3) The Contractor shall submit to the Engineer a comprehensive Integrated Testing & Commissioning Plan as required by the PS. The plan shall be submitted on a logical section-by-section basis, using a "top-down" approach describing the testing and commissioning strategies and processes clearly showing how these serve to provide the full verification of the systems and equipment in context of the complete railway system.

(4) The Contractor shall co-ordinate with the Employer and the Engineer and with all interfacing parties to ensure that the proposed test programme and schedule truly demonstrate that the full specified performance requirements are achieved.

(5) The tests shall include, but shall not be limited to the following:-

a) test of all functional and performance requirements for the system;

b) test to demonstrate compliance with all interface specifications; and

c) test of behaviour under failure conditions (e.g. changeover to redundant hardware, initiation of re-configuration functions or reversionary modes of operation, recovery of systems and equipment from failure, demonstrations of planned emergency procedures, etc.).

(6) The Integrated Testing & Commissioning Plan shall identify a comprehensive list of specifications, standards, method statements, procedures, pass/fail criteria, sample records, resources to be made available, drawings and records to be submitted to the Employer's Representative, and a programme showing the dates for testing and for submission of each test procedure.

(7) Test procedures shall be carefully planned to ensure that the work can be executed in the time available. If the available time is restricted, this planning shall include contingency plans to be implemented if testing proceeds slower than anticipated or if defects are discovered that necessitate rectification and subsequent repeat testing etc.

(8) Immediately following the successful integrated Testing & Commissioning of the system or any constituent part, the Contractor shall complete the appropriate commissioning records in the agreed format and submit three signed copies to the Employer's Representative.

(9) The Contractor shall submit requirements and procedures to the Engineer, in respect of the Contractor's scope of work, for Integrated System Tests in conjunction with the Interface Contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria.

(10) Tests on Completion shall also include Integrated Testing. The Contractor shall, following satisfactory completion of tests on his Works, equipment, sub-systems or system, perform, at the direction of the Engineer, programme 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.

(11) The conducting of these Integrated System Tests, by the Contractor and the Interface Contractors, shall include a period of Test running. Necessary interfacing required with the other contractors shall be done by the Contractor as detailed in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 3 - Design and Construction Interfaces" and in Particular Specification V(B).**

(12) **Completion of Test Results :** The results of the Integrated Testing and Commissioning shall be compiled and evaluated by the Engineer and the Contractor.

(13) **Retesting :** If the Works, or a part thereof, or a section, fail to pass the Integrated Testing and Commissioning, the Engineer shall require such failed tests, to be repeated under the same terms and conditions. If such failure and retesting result from a default of the Contractor and cause the Employer to incur additional costs, the same shall be recoverable from the Contractor by the Employer, and may be deducted by the Employer from any payment due, or to become due, to the Contractor.

(14) **Failure to pass Test :** If the Works, or a part thereof, or a Section, fail to pass Integrated Testing and Commissioning and the Contractor in consequence proposes to make any adjustment or modification to the Works or a part thereof, or a section, the Engineer may instruct the Contractor to carry out such adjustment or modification, at his own cost or to other contractor(s) if the item(s) of Works is attributable to other contractor(s) and to satisfy the requirements of Integrated Testing and Commissioning within such time as the Engineer may deem to be reasonable.

(15) **Statutory Requirement :** The Contractor along with others 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.

(16) During integrated testing, the Contractor shall be required to carry out coordination with all interfacing contractors and agencies

20.4.7 Trial Running and Commissioning

(1) Following satisfactory completion of the acceptance Tests and the Integrated System Test, the Employer will commence an extended period of trial running to prove all technical systems, to the satisfaction of the CRS or any other Authorized Official, and to allow all technical systems to settle and to train staff in working procedures. The Contractor shall allow for attendance in respect of the Contractor's scope of work over the whole of this period, which may be expected to include repair activities and also further opportunity for technical staff training.

(2) The particular requirements for tests to be undertaken during the Service Trial are prescribed in the PS.

(3) The Contractor shall provide special and general attendance to the Employer and the Engineer during the Service Trial period as required by the PS.

(4) The Contractor shall co-operate with the Employer and the Engineer and with all interfacing parties to ensure that the proposed Service Trial programme and schedule truly demonstrates that the full, specified performance requirements and operating parameters are achieved.

(5) The Contractor shall review and comment on the Engineer Service Trial Plan and shall identify specifications, standards, method statements, procedures, pass / fail criteria, to the Engineer for inclusion in the Plan.

(6) The Contractor shall not interfere with the Service Trial tests and Validations in any manner. Any need for remedial works required to be performed by the Contractor shall be co-ordinated with the Employer and the Engineer in advance.

(7) Immediately following the successful tests of the system or any constituent part during Service Trial the Contractor shall complete the appropriate commissioning records in the agreed format, submit three signed copies to the Engineer and may then apply for the Taking Over Certificate in accordance with the requirements of the GCC.

20.5 Test Equipment and Facilities

(1) The Contractor shall provide all equipment and services required for testing, including, but not limited to:

i. Laboratory test instruments.

ii. Special test equipment, emulators, simulators and test software, to permit full testing of System functions and performance.

iii. Other items of the System, specified elsewhere as being part of the Contractor's supply, even if not part of the Subsystem under test.

iv. Consumables.

(2) All test instruments shall be subject to routine inspection, testing and calibration by the Contractor.

20.6 Witnessing by the Employer and the Engineer

20.6.1 Notice for Trial, Inspection and/or Test to the Engineer

(1) In relation to all Quality Control Points and Quality Hold Points involving inspection and/or testing by the Contractor, the Contractor shall give the Engineer notice of when the relevant work will be inspected and/or tested. The period of notice shall be as stated in the PS or such period as in the opinion of the Engineer is reasonable and notified to the Contractor. In the absence of any such statement or notice, a reasonable period of notice shall be given by the Contractor.

(2) In relation to all inspection and/or testing notified by the Contractor, the Employer and the Engineer may elect to witness such inspections and/or tests but the Contractor may proceed with the inspections and/or tests notwithstanding the absence of the Employer or the *Engineer* or of any response to the said notice.

(3) If the Contractor is in any doubt whether inspection and/or testing by the *Engineer* is required as a Quality Hold Point, the Contractor shall request that the *Engineer* clarifies his requirements prior to submitting the relevant inspection and testing plan for review, and in any event not later than 30 days.

20.6.2 Timing for Inspection and/or Test by the Employer and the Employer's Representative

(1) The Contractor shall allow the Employer and the Engineer a reasonable time to carry out any inspection and/or testing and to assess the result of any inspection and/or test before proceeding with the Works.

(2) Unless the Employer's Representative's prior review without objection has been obtained, all inspections and/or tests to be carried out or witnessed by the Employer and the Engineer shall be carried out between 0800 and 1800 hours.

20.6.3 Failure to Notify the Engineer

The Employer or the Engineer may reject the test and test results in question, and require the test to be repeated in the event of any failure by the Contractor to notify the Engineer.

20.7 Failures

(1) The Contractor shall rectify all the faults found during testing, and shall arrange for the relevant tests to be repeated. The relevant tests shall only be repeated when the fault has been remedied and the equipment demonstrated to function correctly.

(2) Where remedial measures involve significant modifications that might, in the Engineer's opinion, affect the validity of earlier tests, the Contractor shall repeat the earlier tests and obtain results satisfactory to the Employer and the Engineer before repeating the test in which the fault was first identified.

(3) The Employer or the Engineer shall have the right to order the repeat or abandonment of any test in the event that results demonstrate that the equipment is significantly non-compliant with the Contract.

(4) The Employer or the Engineer shall have the right to suspend any test in the event that errors or failures have become unacceptable. The Employer or the Engineer shall also have the right to suspend any test if a fault was detected by the Contractor but not reported to the Engineer within 24 hours of the detection. In this event, the suspension shall remain in effect until reporting has been brought up to date to the satisfaction of the Employer and the Engineer.

20.8 Repeat Tests

(1) The Contractor shall correct and re-test every fault detected during the tests.

(2) If the test results in a failure of the item under test the provisions of GCC clause 7.5 shall apply.

20.9 Fault Log

(1) The Contractor shall maintain a fault log throughout each series of tests. Every fault detected during the tests will be entered in the log, together with the actions taken to clear and re-test the fault.

(2) The fault log will be retained as part of the permanent quality assurance record for the system and be subject to regular inspection by the Engineer.

20.10 Hardware Failure Reports

(1) For each hardware failure that occurs at any stage of testing, the Contractor shall investigate the failure and prepare a report on its cause(s) and design implications, if any, resulting from such failure. The report shall clearly show:

(a) the observed symptoms;

(b) the most likely cause of the failure;

(c) an analysis of any stress that may have been caused to other components of the equipment being tested as a result of the failure;

(e) whether the failure is a result of any component operating outside its design range; and

(f) whether any design changes should be made to avoid further failures.

(2) All such reports will be retained as part of the permanent quality assurance record for the system, which shall be subject to inspection by the Engineer.

20.11 Software Failure Reports

(1) For each software failure that occurs, once the software has been reviewed without objection for inclusion into the system and is subject to configuration control, the Contractor shall generate a software failure report.

(2) All such reports will be retained as part of the permanent quality assurance record for the system, which shall be subject to inspection by the Engineer.

(3) The report shall clearly show:
(i) the observed symptoms;
(ii) the likely cause;
(iii) the operator input.

(4) The report shall also clearly show the following information which shall be entered when the failure has been investigated:

(i) the actual cause of the failure;
(ii) the corrective action taken; and
(iii) all software modules affected.

21.0 RECORDS

21.1 Records of Tests and Reports

(1) The Contractor shall submit to the Engineer for review not less than six (6) months before commissioning activities commence his proposed format for the commissioning records. The records shall be appropriately sub-divided to make provision for the various parts of the Permanent Works covered by the Contract.

(2) The format of the records shall cover all tests, provide positive identification by serial number for assemblies and sub-assemblies of the Permanent Works and show modifications to Employer's Drawings and diagrams or "as built" data to be certified by the Employer or the Engineer in the course of installation, testing and setting to work of the Works.

(3) The Contractor shall, during the execution of the Works, prepare such reports and records of design, manufacture, installation and testing as may be required in order that a license may be issued or statutory requirements may be met or approval given. Such reports or records shall be adequate to enable each part of the Permanent Works to be commissioned and to meet the requirements of the licensing authority or any standing statutory regulations, and shall be reviewed by the Employer and the Engineer.

(4) The Contractor shall obtain reports of each inspection and/or test. Such reports shall show the results of all the inspections and/or tests carried out and shall certify that the work has been inspected and/or tested in accordance with the requirements of the Contract and that the work complies with the requirements of the Contract.

(5) Any analysis of the results required to confirm that the work complies with the requirements of the Contract shall be compiled and reported to the Engineer.

(6) A representative of the Contractor who has been allocated the required authority under the relevant quality plans shall sign each report of inspection and/or test.

(7) In addition to any other requirements, the report shall contain 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) properties tested or inspected;

j) method of testing or inspection;

k) all relevant checklists and work sheets used during the inspection and/or test , including readings and measurements taken during the tests;

l) test results, including any calculations and graphs;

m) specified acceptance criteria; and

n) other details stated in the Contract.

(8) 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

21.2 Drawings produced by the contractor

(1) Drawings produced by the Contractor including drawings of site layouts, Temporary Works, etc. for submission to the Engineer shall generally be to ISO A1 size. However for smaller size drawings other size ISO A2/A3/A4 can also be submitted if agreed by the Engineer.

(2) They shall display a title block with the information as detailed in **Part 2 "Employer's Requirement, Section V, Volume 6, Appendix 7 - Drawing and CAD Standards"**.

(3) The number of copies to be submitted to the Engineer shall be as stated in the Contract, or as required by Engineer.

(4) The contractor shall provide three sets of "As Built Drawings along with read only electronic version of the same on CD/DVD to the Engineer.

21.3 Progress Photographs and Videography

(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 CD ROM format 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) Photo processing shall be carried out by a competent processing firm to the satisfaction of the Engineer.

(7) The Contractor shall ensure that no photography is permitted on the Site without the agreement of the Engineer.

(8) Important events, construction activities, site visits of VIPs, 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 a CD/DVD with appropriate voice recording describing the event.

21.4 Records of Wage Rates

(1) The Contractor shall keep monthly records of the average, high and low wage rates for each trade/tradesman employed on the Site and records shall be made available to the Engineer during inspection.

22.0 DEFECT NOTIFICATION PERIOD

(1) After the Works are taken over by the Employer in terms of para 10.1 of General conditions of Contract it will be followed by the **Defect Notification Period.**

(2) During this period Contractor shall replace/ remedy the defects occurring under normal usage of Works by the Employer, except for normal wear and tear under such usage.

(3) Maintenance activities to be done during Defect Notification Period shall be done by the Employer at its own cost and through separate agency.

(4) The Contractor shall submit a manpower plan showing the Contractor's organization available during Defect Notification Period.

(5) The Contractor shall attend the Monthly Meeting with the Engineer to discuss the defects arising during the Defect Notification Period. The dates and agenda of the meeting shall be agreed with the Engineer.

23.0 OPERATION & MAINTENANCE SUPPORT PLAN

(1) The Contractor shall provide an operation and maintenance (O&M) support plan that shall include such items as:

(a) Procedures for O & M for each item, unit / equipment including routine inspection, periodical overhaul and test running;

(b) Technical manuals;

(c) Initial provision of spares, facilities, test equipment, tools, jigs and fixtures.

(d) Manpower required for maintenance

(e) Training requirements;

(f) Procedures for removal and replacement of components;

(g) Periodic running of equipment and machines which would otherwise deteriorate because of non-operation for extended periods.

(h) Procedure for handling break downs.

(i) On completion of the Works the Contractor shall deliver to the Engineer copies of all manufacturing drawings, schedules and software for all components, as well the As-Built Drawings as specified in PS.

(2) Spares List

(a) The Contractor shall submit a schedule of recommended spare parts required duly indicating the quantities required for each item of spares, its description, part number, drawing number, lead time, shelf life and number of units required for the period of five years (beyond DNP), name and addresses of principal as well as secondary sources of supply of each spare.

(c) This recommended schedule shall include all types of consumable, unit exchange and emergency spares, the Contractor shall also advise the recommended inventory having regard to the lead time of the respective items.

(d) The Contractor shall:

- Submit to the Engineer a list of spares required for the life of the plant & equipment, manufactured items and system / sub-system;
- Base the spares calculations on the reliability and availability data and the criticality of the equipment;
- Submit to the Engineer for review the calculations of quantities required and the proposed spares list;
- Submit to the Engineer a system for easy identification of spares.
- The contractor shall establish computer based spare inventory plan to manage the contract spare inventory by employer.

(e) The Spares list shall:

- be grouped by plant & equipment, manufactured items and system / sub-system, test equipment and special tools as applicable for stocking identification;
- have detailed description with drawing references and correlation with the maintenance manuals.

(f) In the event that any of the spares identified have a particular shelf life or special storage requirement, this shall be made known to the Engineer with the submission of the spares list, including the necessary action for disposal or storage.

(g) All spare equipment identified on the spares list, shall conform to Identification and Configuration Control requirements established by the Contractor for the equipment provided under the Contract.

24.0 OPERATION AND MAINTENANCE (O&M) MANUALS

24.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of Traction Supply, OHE, Signaling, Telecommunication, SCADA & General Power Supply Services equipment, the Contractor shall produce additional Manuals covering the additional provisions (if any) 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.

24.2 With reference to the requirements as above:

(a) The Contractor shall produce manuals for all equipment and manufactured items, and sub-systems supplied (if any) for their efficient operations and maintenance. These shall include, but may not necessarily be limited to, the following:

- Manual for Maintenance of Traction Power Supply Equipment
- Manual for Maintenance of Traction Overhead Equipment
- Manual for maintenance of SCADA System
- Manual for maintenance of Signalling System
- Manual for maintenance of Telecommunication System
- Manual for maintenance of General Power Supply Services System
- Manual for Monitoring of the Traction Equipment for use by Maintenance Depots.
- System / sub-system Manuals - A comprehensive description of all system principles at block diagram level.
- Operating/User Manuals - broken into as many sub-sections as may be necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system.
- Workshop Manuals - installation and circuit descriptions, full schematics,

circuits, wiring diagrams, mechanical construction drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

- Software System Manuals - for each software package and each piece of equipment which incorporate programmable devices, 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".
- Equipment Room Manuals - all wiring diagrams and circuits, equipment layout, terminal and cable listing and including such external equipment as may be necessary for completeness.
- Maintenance and Servicing Manuals - to specify requirements, procedures and servicing intervals for planned preventative maintenance and in addition to convey sufficient information on equipment principles and practice to enable first line fault diagnosis and rectification by technician staff.
- Configuration manual for SCADA

(b) Operation & Maintenance manual shall also contain the following

- Technical description of each system and item of equipment installed, written to ensure that the Employers staff fully understands the scope and facilities provided.
- Diagrammatic drawings of each system indicating principle components and items of equipment
- Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment
- 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
- Procedures for fault location and isolation
- Maintenance procedures and their periodicity.
- Tools and Plant needed for maintenance of different Equipment and components.
- All test results conducted on the relevant equipment whether at the manufacturer's place or at site
- 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.

(c) The sub-systems / systems and Operating/User Manuals and a summary (suitable for use at technician level) of the Maintenance and Servicing Manuals shall be prepared in both English and Hindi languages unless otherwise instructed by the Engineer.

(d) The Contractor shall submit all the Manuals for review by the Engineer prior to Factory Acceptance Tests which shall be submitted not later than 4 months from the targeted date of start of Trial Running for the Engineer's consent.

(e) The Contractor shall provide six controlled copies of all Manuals along with Electronic version for the use of the Engineer.

(f) The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period wherever applicable.

(g) O&M Manuals and drawings as submitted by the Contractor shall be updated by him during the Defects Notification Period, if required, and shall be re-submitted to the Engineer for review without any extra cost to the Employer.

25.0 SPARES, SPECIAL TOOLS, TEST EQUIPMENT AND M&P

This shall be as per Part 2 Vol. 7, 8 &9 Particular Specification. All spares, special tools and test equipment and M&P shall be consigned to the employer and delivered in accordance with the Engineer's instruction to a program which shall ensure that spares, special tools and test equipments and M&P are delivered to facilitate normal routine maintenance of the permanent works by the Employer at all stages of completion as defined in sub clause 8.2 of Section-VII Part-3.

26.0 TRAINING

This shall be as per Part 2 Vol. 7, 8 & 9 Particular Specification.

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Section V(A). Employer's Requirement

Volume 6 – Appendices

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APPENDIX - 1

UTILITIES

1.0 All the chartered (visible) and unchartered (un-visible) utilities along the track alignment have been removed/Relocated by the employer. However any minor hindrances coming in the way of track alignment have to be removed or relocated by the Contractor at no extra cost.

2.0 The contractor will arrange the right of way/necessary working clearance of trees and other obstructions on either side of the alignment of the line including cutting/trimming of trees falling in the required corridor of Transmission Line and obtaining their statutory clearance. During the construction works, there may be unavoidable damage to crops, trees etc. both in erection of the line and making temporary approach roads to the line. Compensation of this account, if any will be paid directly by the contractor. Any avoidable or deliberate damage done to standing crops or private property by the contractor's laborers shall be contractor's responsibility.

3.0 Any extra land required by the contractor temporarily for dumping of construction materials and consequent damage of crop etc. shall be the responsibility of the contractor. If any permission, permits are required to be arranged from any Govt. or Local authorities for smooth execution of the work, this will be arranged by the contractor as and when required. Jungle clearance/tree cutting, if any along the line shall be arranged by the contractor.

4.0 **Procedure for Removal of Trees**

i) The felling/re-plantation of trees is governed by the relevant preservation of trees legislation of the Government of India or the concerned Sate Government.

ii) If for the purposes of the System works trees are required to be cut/trimmed/re-planted or removed, the Contractor must notify the Engineer of the tree felling requirements.

ii) Subject to compliance with the aforementioned legislation, arrangements for tree felling may be made by the Contractor and appropriate replacement of felled trees, as required by the legislation shall also be made by the Contractor at his own cost.

iii) If any trees are required to be felled/re-planted, then such trees are to be identified by the Contractor and brought to the notice of Engineer in advance. Such trees shall be limited to those which cause a material adverse effect on the construction of Works.

iv) The Contractor shall obtain the applicable permits for felling/re-plantation of such trees from the concerned authorities and the Employer shall assist him in this regard.

v) The felled trees shall be deemed to be the property of Contractor unless deemed otherwise by the legislation vide item i) above.

vi) No cost for cutting/ replanting/ relocating of trees shall be paid to the Contractor as unchartered utility.

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APPENDIX - 2

WORKS AREAS AND CONTRACT STAGES

1. Works Areas

(1) The Contractor shall divide the Site into separate Works Areas/Railway Envelopes and shall elaborate a schedule for the time periods of the availability of these areas for his contract performance. This should be synchronized with the **Schedule of access to Site provided in Appendix to Tender – Part 3 of the Bid Document** taking account of the Contractor's co-ordination and integration responsibilities with the interfacing contractors.

(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.

(3) The schedule as per (1) and (2) above shall include, but not limited to the following data:

a) Indication of the Works Areas;

b) Description and intended use of the Works Areas;

c) The start and the end date of the availability of the Works Areas, required by the Contractor;

d) The start and the end date of the periods in which the Contractor is to allow the Works Areas to be accessed by interfacing party(ies).

(4) The information as in (1) and (2) above 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.

(5) On the basis of the approved information as in (1) and (2) above the Contractor shall submit proposals for the use and the occupation of the Works Areas, such submissions being at least fifty six (56) days prior to the programmed use of the specific Works Area.

(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:

a) Construct all Permanent Works within the Works Area, to the extent as defined in the Definitive design and in accordance with the requirements of the Contract;

b) Reinstate the area to the same condition as it was taken over;

c) 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;

d) Remove all rubbish, debris and other materials.

e) Carry out and record jointly with the Engineer and interfacing contractors a condition survey of the area.

(7) Restrictions on the timing of occupation so as to avoid affecting operation will be made.

(8) Temporary electrical works provisions in Works Areas are detailed in **"Employer's Requirement, Section V(A), Volume 6, Appendix 8 – Temporary Power Supply"**.

(9) The interfacing parties shall be required to vacate the Works Areas at least 56 days before the due date for handing back of the Works Areas from the Contractor to the Employer, thus allowing the Contractor to clear and reinstate the works areas in accordance with the Contract.

(10) 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.

(11) The Contractor shall ensure that access to every portion of the Site is continually available to the Employer and Engineer.

(12) 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.

(13) Employer will take over the entire stretch as per para 10.1 of General Conditions of Contract.

(14) 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 occur as a result of use of such access or egress by its employees and sub-contractors.

2. Standard Engineering Conditions

The following standard engineering conditions apply to all Works Areas:

a) Forming of Areas

i. The Works Areas shall be formed to the levels shown on the drawings. No levels shall be amended without prior consent of the Engineer.

ii. 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.

iii. Measures shall be taken to the satisfaction of the Engineer to ensure all areas are properly drained and kept free of static water.

b) Roads and Parking

i. Space shall be provided within the Works Areas for parking, loading/unloading and maneuvering of motor vehicles.

ii. 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.

c) Drainage and Sewerage

i. All storm or rainwater from the Work Areas including any access roads thereto shall be conveyed to the nearest stream course, which has the necessary capacity, catch-pit, and channel or storm water.

ii. 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.

iii. 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.

iv. Treatment and disposal of sewage and wastewater from the Works Area shall be provided to the satisfaction of the Engineer following the ecological requirements.

d) Buildings

i. No permanent structures other than those required for the Permanent Works shall be permitted on the Works Areas.

ii. The Contractor, as required, for all temporary buildings, shall provide electricity, water, telephone and sewerage.

e) Pedestrian Access

Any accesses or passing through the Works Areas shall be maintained in a usable condition at all times to the satisfaction of the Engineer including lighting, signing and guarding.

f) Fencing and Signboards

i. For executing the work in urban areas, the Contractor shall erect hoardings, fences and gates around its areas of operations to prevent entry by unauthorised persons to his Works Areas and necessary identity cards /permits should be issued to workers and staff by the Contractor.

ii. For executing the work in 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 as detailed in **para 14.2 Part 2 "Employer's Requirement, Section V(A), Volume 5 – Manufacturing, supply, installation, Testing and Commissioning".**

iii. The Contractor shall submit proposal for fencing of the complete/ partial perimeter of all Works in any urban areas to the Engineer. No work shall be commenced in any Urban Area until the Engineer has been satisfied that the fencing installed by the Contractor is sufficient to prevent, within reason, unauthorised entry / accidents.

iv. For areas other than urban areas, the work Site shall be suitably fenced to prevent, within reason, unauthorised entry / accidents.

v. Project signboards shall be erected before commencement of the Works.

vi. The types, sizes and locations of project signboards shall be agreed with the Engineer before manufacture and erection. Other advertising signs shall not be erected on the Site.

vii. The consent of the Engineer shall be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in positions after the completion of the Works shall be repaired and repainted as instructed by the Engineer.

viii. Hoardings, fences, gates and signs shall be maintained in good order by the Contractor until the completion of the Works, whether such hoardings, fences, gates and signs have been installed by the Contractor or by others and transferred to the Contractor during the period of the Works.

ix. All hoardings, fences, gates and signs installed by the Contractor shall be lit during night or low visibility as required and advised by the Engineer and removed by the Contractor upon the completion of the Works, unless otherwise directed by the Engineer.

x. Hoarding/fencing can be reused after removing from one place to other locations/Sites provided they are maintained in good condition and agreed by the Engineer.

xi. Damage/worn-out fencing/hoarding shall be replaced by Contractor within 24 hours. Engineer's decision regarding need for replacement shall be final and binding and if no action is taken by Contractor the cost of any repairs will be deducted by the Engineer from any payment due to the Contractor.

3. Contract Stages

(1) The Contractor shall divide the Works into Stages.

(2) These Stages shall be achieved by Key Dates/Milestones mentioned in **"Employer's Requirement, Section V(A) , Volume 6, Appendix 4 – Project Program Requirements"**. For this purpose the Contractor shall elaborate a schedule of his own internal schedule to achieve these Key Dates/Milestones.

(3) The schedule of achieving these Key Dates/milestones as per the previous sub-item shall be submitted as part of the Contractor's Preliminary design and shall be subject to agreement by the Engineer.

(4) The schedule of Key Dates shall include, but not limited to the following data:

a) Stage identification;

b) Key Date No.;

c) interfacing parties (information to be provided by the Engineer);

d) Related bodies and/or organisations certifications/approvals;

e) Works to be performed and/or actions to be executed before the Key Date/milestone;

f) Intended achievements.

(5) Completion of works at a Key date/Milestone does not imply handing over of the appropriate Works Area to any other interfacing party.

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APPENDIX - 3

DESIGN AND CONSTRUCTION INTERFACES

1 General

(1) The Track works Contractor will be responsible for the interface of all the interface planning and management of all the interface issues between the Track Works Contract and the Systems Contract.

(2) The systems works contractor will be responsible for the interface planning and management of all the systems works within the scope of the works of the systems works contract. .

(3) The Contractor shall co-ordinate its interface requirements with the Employer and other interfacing contractors, which the Employer may engage from time to time in such a manner as to minimise disruption to any party arising from such concurrent work.

(4) The co-ordination responsibilities of the Contractor shall include but not be limited to the following:

(a) Provision of all information reasonably required by the interfacing parties in a timely and professional manner to allow them to proceed with their design or construction activities and specifically to meet their contractual obligations.

(b) Assurance that the interfacing parties' requirements are provided to all other interfacing parties in time providing them ample opportunity to do their part of requirement for interfacing.

(c) Receipt from the interfacing parties of such information as is reasonably required to enable the Contractor to meet the design submission schedule as identified in **Part 2 "Employer's Requirement, Section V (A) , Volume 3 – Design Procedures and Processes"**.

(d) Where the execution of the work of the interfacing parties depends upon the Site management or information to be given by the Contractor, the Contractor shall provide to such interfacing parties the services or information required to enable them to meet their own programme or to enable them to construct their work.

(e) Co-ordination of track possessions, access and delivery routes, and assurance that all provisions for access and delivery of Plant are co-ordinated with and reflected in the interfacing parties' delivery route drawings.

(f) Co-ordination with the interfacing parties on attendance.

(g) The Contractor shall conduct separate meetings with the interfacing parties as necessary to clarify particular aspects of the interfacing requirements of the Works.

(h) The party convening the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.

(i) Assurance, copies of all those correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's co-ordination with the interfacing parties are issued to all concerned parties and four (4) copies issued to the Engineer no later than seven (7) calendar days from the date of such correspondence and meetings.

(5) The Contractor shall, in carrying out his co-ordination responsibilities, provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the interfacing parties as to the extent of services or information required to pass between them.

(6) If such disagreement cannot be resolved by the Contractor despite having taken all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

(7) Where an interfacing contract is yet to be awarded, the Contractor shall proceed with the co-ordination activities with the Engineer until such time as the interfacing contractor is appointed.

(8) The Contractor shall note that the information exchange is an iterative process requiring the exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the respective dates.

(9) The Contractor shall co-ordinate with the Engineer on all matters relating to works that may affect the IR operation on the existing railway such works shall be carried out in accordance with IR Rules and Regulations.

2. Interface Management Plan

(1) Contractor shall be responsible for identifying all internal and external interfaces and shall develop and maintain a full interface management system which shall cover the functional and technical aspects of all the internal and external interfaces of the Contractor.

(2) The Contractor shall prepare an Interface Management Plan within twenty eight (28) days of Commencement Date which shall identify the interface manager, the structure and responsibilities of the interface management team and the procedures that will be implemented to identify and close out all interfaces.

(3) The Interface Management Plan shall:

a) identify the sub-systems as well as the works and facilities with interfacing requirements

b) define the authority and responsibility of the Contractor's and all other contractors' (and any relevant sub-contractors') staff involved in interface management and development

c) identify the information to be exchanged, precise division of responsibility between the Contractor and the other contractors and integrated tests to be performed at each phase of the Contractor’s and the civil and other contractors' works

d) Address the works programme of the Contract to meet the key dates of each contractor and highlight any programme risks requiring the Employer’s attention keeping in view timeline of systems contractor as mentioned in item 1 (2) above.

e) Address the interface issues during Design as well Construction as detailed in para 2.1 and 2.2 below.

(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 contractors.

(5) The timescale for resolving interfaces shall be set down in Co-ordinated Interfacing and Installation Plans (CIIP) and with the other contractors as detailed in para 2.2 (4) below.

(6) All interfaces shall be documented through the use of interface co-ordination documents to ensure that each interface is identified, the responsibilities to provide information are defined, the criteria for resolution are agreed and the progress to resolution can be tracked at all times.

2.1 Design Interface

(1) The Contractor shall commence the design interface with the interfacing contractor as soon as he has been notified by the Engineer that an interfacing contract has been awarded.

(2) In the case of utility agencies and other statutory boards, interfacing shall commence as soon as it is practicable.

(3) The Contractor shall, immediately upon award of the Contract, gather all necessary information and develop his design to a level where meaningful interaction can take place.

(4) The Contractor shall submit together with each of his Design submissions a joint statement from the Contractor and the relevant interfacing party confirming that design co-ordination has been completed and that they have jointly reviewed the appropriate document to ensure that a consistent design is being presented.

(5) The design interface is an iterative process requiring regular exchange and update of interfacing information and the Contractor shall ensure that the information it requires from the interfacing parties is made known at the outset of each design interface so that the information can be provided in time for the Contractor and the interfacing parties to complete their design to meet their various design submission stages.

2.2 Construction/Installatoin Interface

(1) Construction/Installation interfacing will be necessary throughout the duration of the Works commencing from the time the Contractor mobilises on the Site to the completion of the Works. Construction interfacing will overlap the design interface and involve the definition of interfacing parties' requirements. That are to be incorporated at the initial stages of the Contractor's installation up to provision of attendance during the testing and commissioning stage.

(2) The Contractor shall ensure that there is no interference with the Works of the interfacing parties and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner.

(3) The Contractor shall carry out and complete the Works, or any part thereof, in such order as may be agreed by the Engineer or in such revised order as may be instructed by the Engineer from time to time.

(4) The Contractor shall liaise with the other contractors in the preparation of CIIP which shall be plans prepared collectively and agreed between the Contractor and each other contractor.

(a) These CIIPs shall show, in respect of each other contractor, a design interface and co-ordination period and a Site access, installation interfacing and co-ordination period.

(b) The first period shall be sufficient for the Contractor and the other contractors to integrate the designs of their respective works.

(c) The second period shall be agreed between the Contractor and the other contractors to ensure that each has sufficient access to the Site for the purpose of carrying out their respective works.

(d) The CIIP shall be fully conforming to the approved Works Programme and shall be in logical agreement with all access dates and Key Dates which shall be clearly identified in the CIIP.

(e) The CIIP shall indicate dates for the commencement and completion of each principal activity on Site, and delivery and installation of principal items of equipment.

(f) The initial CIIP shall be submitted to the Engineer within twenty eight (28) days of Commencement Date. Thereafter the CIIP shall be updated at regular intervals not exceeding 28 days and agreed with other contractors subject to the approval of the Engineer.

(g) Should it appear to the Engineer that the actual progress of the Works, the Works Programme or the three month rolling programme do not conform with the CIIP, the Contractor shall be required to revise all such programmes and plans such that they do reflect the progress of the Works, are mutually consistent and conform to other provisions of the Contract.

(h) The CIIP shall allow adequate time periods for each interfacing party and the Contractor to install their plant and equipment in the interfacing areas.

(i) The CIP shall be agreed with and signed off by each interfacing party and then submitted to the Engineer no later than three (3) months before the earliest Works Area access date.

2.3 Employer's/Engineer's Input

(1) The Engineer will coordinate the activities of the Contractor with reference to interfacing with other contractors and agencies during all the phases of the Contract.

(2) The Employer/Engineer, within the scope of the relevant Contract provisions, will support and assist the Contractor 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 tax authorities for VAT reimbursement arrangements;

(c) Interfacing with State and local authorities for implementation of the additional land acquisition procedures;

(d) 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** release the Contractor of any of his obligations under this Contract.

3. Interface Management

(1) The Contractor shall create, in co-ordination with the other contractors, an Interface Co-ordination Document (ICD) for each interface, which shall be signed by all the parties involved.

(2) An interface list shall be prepared and maintained by the Contractor and updated on a regular basis to reflect the actual needs of both parties.

(3) The Contractor shall co-ordinate all interface items on the list and agreed solutions with the other contractors.

4. Dedicated Co-Ordinated Team

(1) The Contractor shall establish a dedicated co-ordination team, led by a Co-ordinator reporting to the Contractor's Project Manager.

(2) The primary function of the team is to provide a vital link between the Contractor's design and manufacturing teams and the Track and other contractors. The Contractor shall provide the Engineer with particulars of the co-ordinator.

(3) The Engineer shall have the right to require the replacement of the co-ordinator if in his opinion the co-ordinator is unable to meet the co-ordination requirements of the Contract.

(4) The Contractor's attention is drawn to the need for the co-ordinator to establish effective dialogues and communication links with the Civil and other interfacing contractors. The Contractor's co-ordination team for interfacing shall comprise a mix of personnel with experience in both design and manufacture of equipment comprising the Works, necessary for effective co-ordination.

(5) The co-ordinator shall assess the progress of co-ordination with Civil and other contractors by establishing lines of communications and promoting regular exchange and updating of information so as to maintain the Contractor's programme.

(6) The complexity of the project and the importance of ensuring that work is executed within time limitations require detailed programming and monitoring of progress so that early programme adjustments can be made in order to minimise the effects of potential delays.

(7) The Co-ordinator in conjunction with the civil and other contractors shall identify necessary provisions in the Works for plant, equipment and facilities of the civil and other contractors. These provisions shall be allowed by the Contractor in his design of the Works.

5. Co-Ordination with Other Contractors and Indian Railways

(1) The Contractor shall undertake design co-ordination with the other contractors, state utilities and Indian Railways.

(2) The Contractor may commence design interfacing with other contractors and Indian Railways prior to the given period once information has been developed to a level where meaningful interaction can take place.

(3) Design co-ordination shall include, but not be limited to, the following:

a) Definition and agreement with other contractors of interface areas and contract limits;

b) Definition and design approach by the Contractor with the other contractors and/or Indian Railways regarding environmental control requirements, system functionality requirements and control interfaces;

c) Agreement of combined service drawings and structural opening drawings

(4) The Contractor shall liaise with the Engineer in developing a uniform identity code system which shall be used to uniquely identify each item of equipment and software component provided under this Contract and provided by the other contractors and/or Indian Railway.

(5) Such identity codes shall be used for labeling each item of equipment and shall also be used in design reports, drawings and operations and maintenance manuals. Such codes shall comprise mnemonics for location names and equipment types as well as alpha-numeric for unique numbering.

(6) The Contractor shall undertake Site activity co-ordination with the other contractors and/or Indian Railways within the periods stated for access and installation interfacing and co-ordination in the agreed CIIP.

(7) The Contractor shall undertake installation and testing in accordance with the milestones set in the Contract and the dates in the CIIP and as agreed with the other contractors and/or Indian Railways.

(8) The Contractor shall undertake a lead role in the co-ordination of the activities associated with integrated systems testing including the co-ordination of other contractors and/or Indian Railways to test and monitor their systems to prove the design and integrity of the systems as a whole.

(9) It shall be the responsibility of the Contractor to secure from the other contractors and/or Indian Railways, in a timely and correct manner as per the agreed CIIP, whatever interface provision is required for the Contractor to carry out its duties under the Contract.

(10) Any additional costs arising to the Contractor due to his late and/or improper interfacing with the other contractors and/or Indian Railways, shall be to the Contractor's account. Such improper interfacing shall include, but not be limited to:

a) Late provision of interfacing information

b) Failure to adhere to agreed interface

c) Changing an interface after it has already been agreed and signed off

(11) Works will be taken over by the Employer as per clause 10.1 of Contract conditions.

(12) Buildings in the project and E&M facilities at a glance are given as below:

Buildings in Mughalsarai – Sonnagar and Chiraillapathu Section

Buildings	Constructed by	Local Supply	DG Set	UPS	Solar System	AT with ASTS	Wiring and Illumination	Fan	Air Conditioner	Circulating Area Lighting	Lightening Protection Arrangement
New ERC Mughalsarai	System Contractor	N	N	N	N	Y	Y	Y	Y	Y	Y
		--	--	--	--	PS(Elect)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)
New Ganjkhwaja Station	System Contractor	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		PS(Elect)	PS(Elect)	PS(Elect)	PS(Elect)	PS(Elect)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)
New Sonnagar Link	System Contractor	N	N	N	N	Y	Y	Y	Y	Y	Y
		--	--	--	--	PS(Elect)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)
New Sonnagar Station with end cabins	Civil Contractor	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		PS(Elect)	PS(Elect)	PS(Elect)	PS(Elect)	PS(Elect)	Civil Contractor	PS(Elect)	PS(Elect)	PS(Elect)	PS(Elect)
New Chiraillapathu	System Contractor	N	N	N	N	Y	Y	Y	Y	Y	Y
		--	--	--	--	PS(Elect)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)	PS(Sig)
Auto Signalling Tele Huts	System Contractor	N	N	N	N	Y	Y	Y	Y	N	Y
		--	--	--	--	PS(Elect)	PS(Sig)	PS(Sig)	PS(Sig)	--	PS(Sig)
LC Gates Huts	System Contractor	N	N	N	N	Y	Y	Y	N	N	Y
		--	--	--	--	PS(Elect)	PS(Sig)	PS(Sig)	--	--	PS(Sig)

Solar Panel system will also be provided at TSS control building as indicated in Chapter 13 of Vol 9: PS(Electric)

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APPENDIX - 4

PROJECT PROGRAM REQUIREMENTS

1. General

(1) In accordance with the General Conditions of Contract Clause 8.3 the Contractor shall submit his detailed time program to the Engineer within twenty eight (28) days of the Commencement Date of the Works.

(2) The Programme as per the previous sub-item (1) above shall be supplemented at the time of the Contractor's Preliminary Design submission by **Part 2 "Employer's Requirement, Section V (A), Volume 6, Appendix 2 – Work Areas and Contract Stages" ,** duly approved in accordance with the contract provisions, these appendices becoming an inseparable part of the said Programme.

(3) In compiling its Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for co-ordinating and completing the design, construction, procurement, manufacture, supply, installation, testing, commissioning and integrated testing of the Works.

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

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

(6) The Works Programme shall take full account of the Design submission programme.

(7) This supplementing, however, shall not relieve the Contractor from his obligation to observe the overall Contract performance term as mentioned in Contract conditions.

(8) The Contractor shall, during the progress of the Works, constantly monitor his progress against the programmes described below.

(9) The Works Programme, and all more detailed or revised versions, shall be submitted to the Engineer for his consent in accordance with the provisions of the conditions of Contract.

2. Milestones

Milestones have been derived from clauses 8.2, 8.7 and 10.1 of Conditions of Contract. These are the broad key deliverables and Contractor is required to develop project program to achieve these deliverables and dates. Accordingly contractor should set his own internal targets which are commensurate with these Milestones and incorporate in his all internal schedules for approval of Engineer. The details of Milestones and Key Dates are mentioned under appropriate clauses in Section VII, Part 3 of Bid Document.

3. PMIS Requirements and Procedures

(1) Timely performance is of the essence on this project. The Contractor may complete the project or any part of the Project earlier than is stipulated in the Contract and the Milestone requirements.

(2) All design and/or construction work, including all sub-contractors' work, under this Contract shall be planned, scheduled, executed, reported and accomplished using the precedence diagramming Critical Path Method (hereinafter referred to as CPM). The work required by this section includes the requirement to prepare, maintain, and update all detailed schedules as described in this section. The CPM schedules shall be prepared in such a manner as to permit the orderly planning, organization, and execution of the Work and be sufficiently detailed to accurately depict all the work required by the Contract. The Contractor shall resource (labor and equipment) and cost load its schedule as specified herein.

(3) All schedules and schedule submittals under this Contract shall be computerized by the Contractor utilizing the latest version of ORACLE PRIMAVERA P6 PROFESSIONAL PROJECT MANAGEMENT SOFTWARE, hereinafter referred to as ORACLE PRIMAVERA

P6 or any other software approved/instructed by Engineer. The Contractor shall have sufficient capabilities to perform this work and share the PMIS with the Engineer and the Employer.

(4) The Contractor shall formally transmit all schedule submittals and schedule narratives identified herein to the Engineer in the form of four (4) hard copies and one (1) soft copy on a CD at the times identified herein or at the request of the Engineer.

(5) The primary objectives of the requirements of this section are:

a) To ensure adequate planning and execution of the Works by the Contractor;

b) To assist the Engineer in evaluating progress of the Works;

c) To provide for optimum coordination by the Contractor of its trades, Sub-contractors, and suppliers, and of its work with the Works or services provided by any separate contractors;

d) To permit the timely prediction or detection of events or occurrences which may affect the timely prosecution of the Works;

e) To provide a mechanism or tool for use by the Engineer and the Contractor in determining and monitoring any actions of the Contractor which may be required in order to comply with the requirements of the Contract documents relating to the completion of the various portions of the Works by the Contract Milestones and Contract completion specified in the Contract documents.

(6) The Contractor is responsible for determining the sequence of activities, the time estimates for the detailed design and construction activities and the means, methods, techniques and procedures to be employed. The schedules identified herein shall represent the Contractor's best judgment of how it will execute the Work in compliance with the Contract requirements. The Contractor shall ensure that the schedule is current and accurate and is properly and timely monitored, updated and revised as project conditions may require and as required by the Contract documents.

(7) The Contractor shall provide the basic data relating to activities, durations, specified Contract Milestones, and sequences to the Engineer, as part of Contractor required schedule submittals. This data shall reflect the Contractor's actual plan for the project, and shall fully comply with all requirements of the Contract documents.

(8) Subject to the Engineer’s agreement and unless identified elsewhere in the Contract documents, the Contractor shall determine when, where, and how it will interface with others performing work on the program and to coordinate its activities with all parties including the Employer and its consultants, suppliers and other contractors.

(9) The Contractor shall include in the interim schedule and Contract baseline schedule all interface points with others. These points shall be in the form of start milestones for deliverables due to the Contractor from others and as Finish Milestones for deliverables that Contractor must supply to others.

4. Scheduler Qualifications

(1) The Contractor shall have within its employment or under contract, throughout the execution of the Work, such expertise in CPM scheduling and experience so as to ensure its effective and efficient performance under this Contract.

5. Schedule Orientation Session

(1) The Contractor shall, upon notification from the Engineer, attend a schedule orientation session relating to the schedules and reports requirements for this Contract. The schedule orientation session is designed to review in detail, the objectives of the schedules and reports requirements and the requirements. The Contractor shall arrange for its Project Manager, superintendent, and scheduler to attend the schedule orientation session.

(2) The following items shall be discussed during the schedule orientation session:

a) The procedures and requirements for the preparation of the interim schedule, contract baseline schedule, and monthly updates by Contractor;

b) How the requirements of the Contract documents will be monitored and enforced by the Engineer;

c) Long-lead items and time requirements for the Work by sub-contractors will be identified and included in the contract baseline schedule;

d) Work packages;

e) Coding and logic for the contract baseline schedule; and

f) Identification and scheduling of Shop Drawings and other submittals;

g) Listing of major project milestones;

h) Cost loading of major project summary activities.

6. Interim Schedule

(1) The Contractor shall submit its interim schedule, to the Engineer for review and acceptance at the Pre-Construction conference (or kick-off meeting for the Design portion of the project). The interim schedule shall indicate a detailed work plan for the first fifty six (56) days after the Commencement Date. Work beyond the first fifty six (56) days shall be in summary form. Use of the accepted interim schedule shall not exceed the first fifty six (56) days after the Commencement Date.

(2) The interim schedule detail plan shall include but not be limited to planned mobilization, sequence of early operations, submittals and procurement of materials and equipment. The interim schedule shall also include the following information as a minimum:

a) Activity identification number of the task or event;

b) Description of the task or event;

c) Duration of the task or event;

d) Earliest start and finish dates for the task or event;

e) Latest start and finish dates for the task or event;

f) Various stages of Design development and Construction completion

g) Milestones for activities given in this document and consequent critical points for interface with others.

h) Logic links to previous tasks upon which the task is dependent before it can start and to subsequent tasks which are dependent on the task to be completed before they can commence

(3) During the first fifty six (56) days following the Commencement Date, the interim schedule shall be updated regularly and submitted to the Engineer to indicate the progress of the Work, unless the contract baseline schedule is approved within fifty six (56) days of Commencement Date. Once the contract baseline schedule is accepted by the Engineer, no further updates of the interim schedule are required.

7. Contract Baseline Schedule

(1) Within forty-two (42) calendar days after the Commencement Date the Contractor shall complete the contract baseline schedule, which expands the accepted interim schedule, and submit it to the Engineer for review and acceptance. The contract baseline schedule submittal shall not show any progress until it is accepted by the Engineer.

(2) The Contractor shall submit to the Engineer a complementary and detailed narrative description of its plan for performing the Work with the submittal of the contract baseline schedule. The narrative description shall summarize the overall approach to design and/or construction sequencing, including, but not be limited to:

a) The anticipated lost days due to weather;

b) The equipment and personnel requirements by craft to complete a resource loaded schedule;

c) Whether it proposes the Work be performed on single, double or triple shifts;

(3) No application for payment shall be accepted until the contract baseline schedule is approved.

8. Acceptance of the Interim Schedule and Contract Baseline Schedule

(1) The Engineer and the Contractor shall review and discuss the interim schedule or contract baseline schedule after it has been submitted to the Engineer.

(2) After the Engineer accepts the interim schedule and contract baseline schedule, these schedules will then be used to monitor and record progress of the Work, forecast completion dates, evaluate revisions and generate the payment application amounts, where applicable. Acceptance of the interim schedule or the contract baseline schedule by the Engineer shall not relieve the Contractor of total responsibility for the Contractor's means and methods, scheduling, sequencing, and prosecuting the Work to comply with the requirements of the Contract.

(3) The Engineer shall have the right to require the Contractor to revise and resubmit the interim schedule and the contract baseline schedule to modify any Contractor data in the schedules or any portion of the schedules that the Engineer determines to be:

a) Impracticable;

b) Based upon erroneous calculations or estimates;

c) Unreasonable;

d) Required in order to ensure proper coordination by the Contractor of the work of its Sub-contractors and with the work or services being provided by any separate contractors;

e) Necessary to avoid undue interference with plant operations or those of any utility owners or adjoining property owners;

f) Necessary to ensure completion of the Work by the Contract Milestones and Contract completion dates set forth in the Contract documents;

g) Required in order for Contractor to comply with any other requirements of the Contract documents;

h) Not in accordance with the Contractor's actual operations, unless the revision or modification will change the original scope of Works. The Contractor shall bear the expense of such revisions. If the Engineer requires such revisions, the Contractor shall revise the interim schedule or contract baseline schedule and submit it for Engineer's acceptance within seven (7) calendar days.

(4) The Engineer reserves the right to require that the Contractor to adjust, add to, or clarify any portion of the schedules that may be determined to be insufficient for monitoring of the Work after the schedules are accepted. No additional compensation shall be provided for such adjustments, additions or clarifications.

9. Schedule Content and Format

(1) All construction activity durations shall be given in working days. The Contractor shall develop activities for the schedules so that no single activity shown has duration longer than fourteen (14) working days, except for procurement and fabrication, delivery, submittal development and approval activities that may have longer durations.

(2) For all equipment and materials to be fabricated or supplied for the Project, the contract baseline schedule shall show a sequence of activities including:

a) Material delivery and storage;

b) Erection or installation;

c) Testing of equipment and materials.

(3) The interim schedule and contract baseline schedule shall show dependencies (or relationships) between each activity. Each activity must have a successor and predecessor, except for the project start and finish milestone. The use of date constraints shall be limited to Contract milestones and Contract completion dates only.

(4) The interim schedule and contract baseline schedule shall contain or be able to demonstrate that the following items have been addressed:

a) The Project's name;

b) The Contractor's name;

c) Revision or edition number;

d) Activities of completed work;

e) Activities relating to different areas of responsibility, such as subcontracted Work which is distinctly separated from that being done by the Contractor directly;

f) Labour resources distinguished by craft or crew requirements;

g) Equipment and material resources distinguished by equipment and material requirements;

h) Distinct and identifiable subdivisions of work such as structural slabs, beams, columns;

i) Locations of work within the contract limit lines that necessitates different times or crews to perform;

j) Outage schedules for existing utility services that will be interrupted during the performance of the Work;

k) Acquisition and installation of equipment and materials supplied and/or installed by the owner or its separate contractors;

l) Material to be stored on Site;

m) Phases;

n) Interim milestones and the Contract Completion dates.

(5) The Contractor shall be responsible for expediting the delivery of all materials and equipment to be furnished by the Contractor so that the progress of construction shall be maintained according to the currently accepted contract baseline schedule for the Works. The Contractor shall notify the Engineer in writing, and in a timely manner, whenever the Contractor anticipates that the delivery date of any material or equipment will be later than the delivery date indicated by the currently accepted contract baseline schedule.

10 Monthly Schedule Update

(1) An update of the accepted interim schedule or contract baseline schedule shall be submitted by the Contractor to the Engineer monthly and with the monthly application for payment. Receipt by the Engineer of the monthly schedule update will be an express condition precedent to processing each invoice.

(2) On a monthly basis, the Contractor shall arrange for its Project Manager, superintendent, and scheduler to meet at the project Site with the Engineer to review Contractor's monthly schedule update. The schedule will be marked-up to show the agreed upon progress, signed by the Contractor, and a signed copy issued to the Project Manager. The monthly schedule update shall show up-to-date and accurate progress of the Works, and shall forecast the completion date for activities in progress based on the contract baseline schedule. The monthly schedule update shall be prepared by the Contractor in consultation with all its principal sub- contractors and suppliers.

(3) The monthly schedule update shall include actual activity data for progress to date, but in the monthly schedule update, the Contractor shall not change the schedule logic, the activity relationships/dependencies, or planned activity durations and shall not add or delete activities. If the Contractor believes that any of these items should be changed, then a proposed revised baseline schedule must be submitted by the Contractor to the Engineer. Although activities shall not be added or deleted in the monthly schedule update, activities associated with Work authorizations that have been recommended for approval shall be included in the next monthly schedule update.

(4) The Contractor will be notified by the Engineer, in writing, as to acceptance, reasons for rejection, or any revisions required to the schedules. Changes to the schedules agreed upon by the Contractor and the Engineer shall be incorporated by the Contractor into the schedules within seven (7) calendar days after agreement.

(5) The monthly schedule update shall show actual activity commencement and completion dates, the actual remaining duration in workdays and physical percent complete for those activities commenced and not complete. For the stored materials, the update shall show the amount of material stored, representing the total cost of the materials delivered and properly stored. The monthly schedule update shall also show a graphic comparison of the current status and the baseline plan for each activity in the network.

(6) Each monthly schedule update shall continue to show all work activities including those already completed. These completed activities shall accurately reflect "as built" information by indicating when activities were actually started and completed.

(7) Monthly schedule updates shall also contain the following information for each activity:

a) Activity identification number, description and estimated original duration in workdays;

b) Calculated early and late finish dates;

c) Actual start and actual finish dates, and remaining duration, in calendar, for those activities started and not completed;

d) Days ahead and/or behind schedule of the milestones representing the specified Contract Milestones and Contract completion dates;

e) Physical percent complete for each activity;

f) A float analysis of the longest path through the schedule detailing potential delays and areas for acceleration. Actual start and finish dates shall be indicated for each activity as appropriate. Completed activities will be omitted from remaining float and late start slots.

11. Revised Baseline Schedule

(1) If the current contract baseline schedule or monthly schedule update no longer represents the actual or planned prosecution and progress of the Work, the Contractor shall submit (at no additional cost to the Employer, a proposed revision to the current contract baseline schedule in accordance with this section.

(2) If the Engineer believes that the current contract baseline schedule or monthly schedule update no longer represents the actual or planned prosecution and progress of the Work, the Engineer may require of the Contractor, and the Contractor shall submit (at no additional cost to the Employer, a proposed revision to the current contract baseline schedule in accordance with this section.

(3) Schedule Revisions, as defined herein, shall refer to modifications made to activities in the accepted interim schedule or contract baseline schedule in any of the following items:

a) Activity duration;

b) Changes in logic connections between activities;

c) Changes in constraints;

d) Changes in value loading;

e) Changes to activity descriptions;

f) Activity additions and deletions.

(4) Any proposed revisions to the contract baseline schedule must be submitted to the Engineer for acceptance. This submittal must include, at a minimum, a written narrative with a full description and reasons for each work activity revised a full schedule printout, and a soft copy of the proposed revised contract baseline schedule. For revisions affecting the sequence of work, the Contractor shall provide a schedule diagram Fragmented Network (Fragnet) which compares the original sequence to the revised sequence of work. This diagram shall maintain the Contract Milestone and Contract completion dates.

12. Recovery Schedule

(1) Should the updated interim schedule, contract baseline schedule or monthly schedule update, at any time during Contractor's performance, show that the Contractor is fourteen (14) or more calendar days behind schedule for any Contract interim Milestone, substantial

completion or for Contract completion, the Contractor shall prepare a recovery schedule separate from the updated and approved monthly schedule update explaining and displaying how the Contractor intends to reschedule its work in order to regain compliance with the contract baseline schedule during the immediate subsequent pay period.

(2) If a recovery schedule is required, the Contractor shall prepare and submit to the Engineer a recovery schedule, incorporating the best available information from sub-contractors and others, which will permit the forecasted completion dates to return to the interim milestones and the Contract completion dates. The Contractor shall prepare a recovery schedule to the same level of detail as the originally accepted contract baseline schedule submittal.

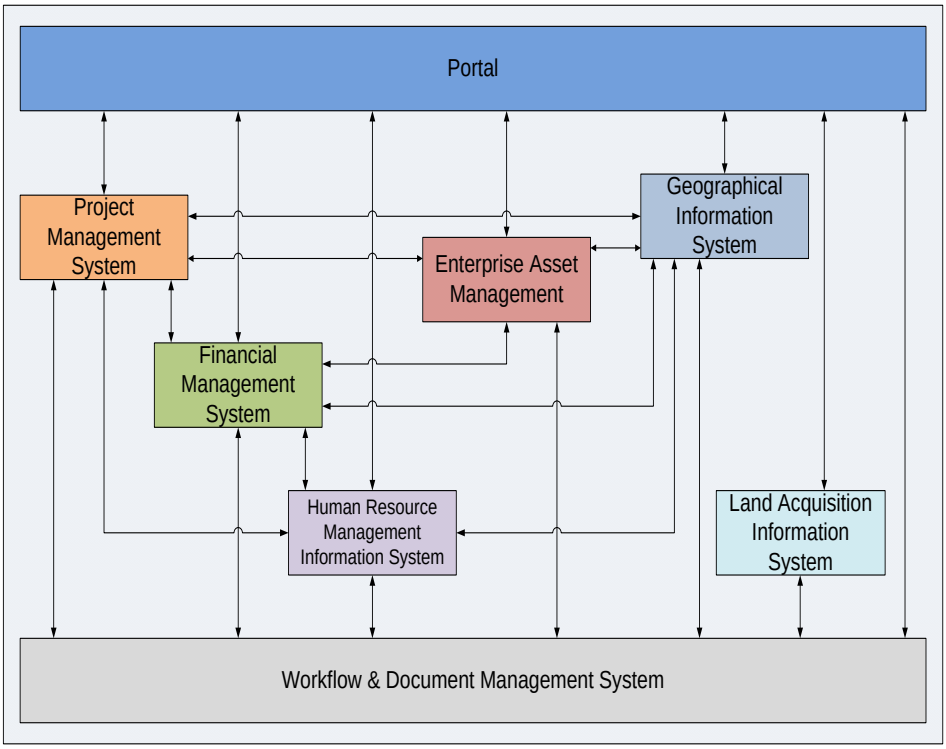
(3) Within seven (7) working days after submission of the recovery schedule, the Contractor shall meet with the Engineer to review and evaluate the recovery schedule. Within seven (7) working days of that meeting, the Contractor shall submit the recovery schedule, including any revisions necessitated by the review, to the Engineer for its review and acceptance. The recovery schedule, once accepted by the Engineer, shall be implemented as the revised contract baseline schedule for the remaining Work.

13. IT Requirement For DFC

1. DFCCIL is in the process of implementing an Enterprise wide IT System through a World Bank Funded Project titled “Supply & Installation of Integrated IT System”. The objective of the IT Plan is to automate core organizational business functions/ processes and develop a working environment that enables higher efficiency and effectiveness, not only in internal functions, but across the entire ecosystem of DFCCIL, including Contractors. A total of eight (8) applications are envisaged for DFCCIL and components of the proposed system include the following elements:
   a) An ERP System for covering Finance & Accounting, HR, Project Managements, General Administration to ensure an integrated management control
   b) A Document Management System to ensure that all drawings/critical documents related to the construction phase are well documented and achieved
   c) A Geographical Information System that will initially have details of every asset that is created. It will have the entire alignment geo-referenced. The monitoring of various Contracts is proposed to be done through Dashboards that will have a significant component of GIS.
   d) An Enterprise Asset Management that has spatial co-ordinates of every asset

2. The proposed IT system has been designed for facilitating preservation of important artifacts (plans, drawings, notes, documents, reports etc) in a secure and manageable environment in digitized format. Appropriate triggers will generate dashboards and management reports every time an event causes a substantial shift in project risk or timeline or is a deviation in processes developed. The envisaged system would expedite decision making, ensure better planning and co-ordination between different functions, better data management, effective reporting, knowledge management, etc. Program Management will provide senior management with critical information related to various contracts, activities and funds in the form of management dashboards with inbuilt triggers to ensure timely decision making.

3. Since most of the Project related Data creation would happen outside DFCCIL core organization, the proposed IT system is largely dependent on data being created and uploaded by Contractors.



4. While DFCCIL would define the data collection templates, Contractor would upload actual data into the system. As such, a part of the Scope of Work of the Contractor will include the following elements:

(i) Upload/definition of Project Plans as per the template and using the software defined by DFCCIL

(ii) Maintenance and updation of uploaded Project Plans in software used by DFCCIL

(iii) Upload of drawings/designs created by Contractor as per the classification and on the software platform defined by DFCCIL

(iv) Online MB (Measurement Book) Entry in Project Monitoring System, in a template defined by DFCCIL.

(v) Asset details needs to be updated in the system in format prescribed by DFCCIL.

(vi) Geo-referencing of the alignment on WGS 84 Coordinates

(vii) Capture and upload of geo-referencing coordinates of the assets into GIS

(viii) Upload of digitally signed invoices for payment processing

5. It will be the responsibility of the Contractor to ensure that there is interoperability between the Contractor's IT System and that being developed by DFCCIL so that movement of information and data across the DFCCIL boundaries is feasible in a seamless manner. This must be factored in, by the bidders, while preparing the price bids."

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APPENDIX - 5

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 no later than the 7th day of each calendar month and shall account for all work actually performed during the last month.

(3) It shall be submitted in English in five hard copies and one copy in CD/DVD.

(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 to any outstanding matters.

(2) A spread sheet indicating the status of all payments due and made including recoveries if any.

(3) A report of the status of any outstanding claims even if these is NIL.

(4) The report shall in particular provide interim updated accounts of continuing claims.

4. Physical Progress

(1) It shall describe the status of work performed in descriptive form, significant accomplishments, including critical items and problem areas including current and anticipated delaying factors and their impact, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues with all agencies involved, problems and resolutions during the period or anticipated.

(2) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Programme.

5. Programme Update (For entire Project)

(1) Programme updating shall include:

a) The monthly programme 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 Programme update shall be accompanied by an activity report and a narrative statement.

c) The narrative statement shall explain the basis of the Contractor’s submittal:

i. Early Work and baseline submittals – explains determination of activity duration and describes the Contractor’s approach for meeting required Key Dates as specified in the Contract **“Employer’s Requirement, Section V(A), Volume 6, Appendix 4 – Project Program Requirements”**..

ii. Updated detail programme submittals – state in the narrative the Works actually completed and reflected along critical path in terms of days ahead or behind allowable dates, specific requirements of narrative are:

- If the updated detailed work programme indicates an actual or potential delay to Contract Completion date or Key Dates, identify causes of delays and provide explanation of work affected and proposed corrective action to meet Key Dates or mitigate potential delays.
- Identification of any deviation from previous month's critical path.
- Identify by activity number and description, activities in progress and activities scheduled to be completed.
- Discuss variation work order items, Value Engineering items, if any.

d) Programme Status which shall:

i. Show Works Programme 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 size A3 or A4 and as a time-related logic network diagram on an A1 media, including activity listings.

e) The activity variance analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.

6. Three-Month Rolling Programme

The three month rolling programme shall be issued on a monthly basis.

7. 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.

8. 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 materials 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.

9. 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

10. Deployment of Manpower Material and Equipment at Site

(1) Detail showing the extent of deployment of manpower, equipments and stock of important construction materials 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 materials 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.

11. Photographs and Videography

Submission requirements for photographs and videography are defined in Clause 21.3, **Part 2 "Employer's Requirement, Section V(A) , Volume 5, Manufacturing, Supply, Installation, Testing and Commissioning**".

12. Quarterly Progress Report

Quarterly progress report will also be submitted on the similar lines.

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APPENDIX - 6

QUALITY ASSURANCE

1. General

(1) The Contractor shall implement a project quality management plan in accordance with EN ISO-9001-2001, international (ISO 9001-2000), "Quality System" - Model for Quality Assurance in Production, Installation and Servicing" to ensure that all materials, workmanship, plant and equipment supplied and work done under the Contract meets the requirements of the contract.

(2) This plan shall apply to all activities related to the quality of items, including designing, purchasing, inspecting, handling, assembling, testing, storing, and shipping of materials and equipment and different elements of construction work and installations of components.

(3) The Contractor shall, within sixty (60) days of the Commencement Date, prepare and submit to the Engineer for review his proposed Quality Assurance Plan, which shall comply with the requirements as mentioned in this **Appendix**.

2. Quality Assurance Management Plan

(1) The Project Quality Management Plan (PQMP) shall as a minimum address the quality system elements as required by EN ISO 9001-2001, generally noting the applicability to the Contractor's Works Programme for the Project.

(2) Procedures or quality plans to be prepared by others (suppliers, sub-contractors, etc) and their incorporation in the overall PQMP shall be identified.

(3) The Contractor shall provide and maintain with the Engineer a Quality Assurance (QA) plan to regulate methods, procedures, and processes to ensure compliance with the Contract requirements.

(4) The QA Plan, including QA written procedures, shall be submitted to the Engineer for his review.

(5) Adequate records shall be maintained in a readily retrievable manner to provide documented evidence of quality monitoring and accountability.

(6) These records shall be available to Engineer at all times during the term of the Contract and during the Defects Notification Period.

(7) The Plan shall identify:

a) special product realisation processes that are product realization activities that control or verify quality and are performed by certified personnel in accordance with documented procedures that have the written consent of the Engineer;

b) Measuring and monitoring procedures shall provide for control and reporting of non-conformances conditions to the Engineer; Inspection shall occur at appropriate points in the installation sequence to ensure compliance with drawings, test specifications, process specifications, and quality standards while the Engineer may designate, if necessary, inspection hold points into construction, installation or inspection planning procedures;

c) Inspection on delivery procedures to preclude the use of nonconforming materials and to ensure that only correct and accepted items are used and installed;

d) Identification, tracking and inspection status system to identify and track the progressive inspection status of equipment, materials, components, construction, subassemblies and assemblies as to their acceptance, rejection, or non-inspection shall be maintained;

e) Identification and control of items: an item identification and traceability control shall be provided;

f) Handling, storage, preservation and delivery: provide for adequate work, surveillance and inspection instructions.

(8) The QA plan shall ensure that conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, and defects in materials and equipment shall be promptly identified and corrected.

(9) The QA plan shall provide for establishing, and maintaining an effective and positive system for controlling non-conforming material including procedures for the identification, segregation, and disposal of all non-conforming material while the use or repair of non-conforming materials shall require the Engineer's consent.

3. Plan Implementation and Verification

(1) The Plan shall clearly define the Quality Assurance (QA) organization. Management responsibility for the QA shall be set forth on the Contractor's policy and organization chart.

(2) The plan shall define the requirements for QA personnel, their skills and training.

(3) Records of personnel certifications shall be maintained and monitored by the QA personnel. These records shall be made available to the Engineer for review, upon request.

(4) The QA operations shall be subject to the Engineer's, Employer or his authorised representative's verification at any time.

(5) 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.

(6) The Contractor's quality audit schedule shall be submitted to the Engineer for consent every three months or more frequently as required.

(7) The results of quality audits shall be summarised in the Contractor's monthly reports.

(8) The Contractor shall provide all necessary access, assistance and facilities to enable the Engineer to carry out on-Site and off-Site surveillance of QA audits to verify that the quality system which has the consent of the Engineer is being implemented fully and properly.

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APPENDIX - 7

DRAWING AND CAD STANDARDS

1.0 Introduction

(1) The purpose of this document is to define the minimum Drawing 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 presentations of Drawings and CAD files, the exchange of drawn information is improved and will maximise the use of CAD in the co-ordination process.

(3) All submissions shall be made to the Employer'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
AutoCAD Graphics	Corel Draw, Ver. 12.0/ AutoCAD 2011 or latest versions
Photographic	Adobe Photoshop CS2 or last 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:

(a) The following guidelines shall be followed when the Contractor uses an internet browser as the communication media to share information with the Engineer /Employer.

(b) All the data formats or standards must be supported by Microsoft Internet Explorer version 7 or above running on Windows XP or above.

(c) 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 Database Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

2.0 GENERAL REQUIREMENTS

2.1 General

(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) A single letter character denoting the status of the drawings e.g.

- T Tender Design
- W Working Drawing
- M Manufacturing Drawing
- S Site Drawing
- D Shop Drawing
- A As Built Drawing

(b) A single digit code denoting the contract number (for the whole line)

- 1 Design
- 2 Civil / Track Works from XXX to XXX.
- 3 Systems Works

(c) A two (2) letter code denoting the type of civil works or system elements e.g.

- 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, TK Track-work

TM Traffic Management (Roads, Pavements)

WS Water Supply

SW Switching Stations

GS Grid Sub-stations

TS Traction Sub-stations

TL Transmission Line

SC SCADA

(d) A unique four (4) digit number (from 0001 to 9999), identifying each drawing.

(e) A single letter (A to Z except I and O) denoting the sequence of revision to the drawing. The initial drawing issue will carry a revision letter "A".

Example:	Drawing Title Block:	
Status	Drawing No:	Revision:
D	1 / ST / 0235	B

(Note: The comparable computer reference is “1ST0235B”)

Denotes:

(D) Shop Drawing (1) Design (ST) Stations (0235B) Drawing number 0235 Rev. B

2.2 Types of Drawings

(1) 'Working drawings' are those as defined in Volume 2 Section V, Part 2 of Bid Documents.

(2) Site drawings and sketches’ are drawings, often in sketch form, prepared on Site to describe modifications of the Working Drawings where Site conditions warrant changes that do not invalidate the design.

(3) 'Shop drawings' are special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.

(4) 'Reference Drawings' are those as defined in Volume 2 Section V, Part 2 of Bid Documents.

(5) 'As-built drawings' are those as defined in Volume 2 Section V, Part 2 of Bidding Documents. These drawings shall be completed on a regular basis as the Works progress, and shall not be left until completion of the entire Works.

3.0 COMPUTER AIDED DESIGN AND DRAWING (CAD) STANDARDS

3.1 Introduction

(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.

3.2 Objectives

(1) The main objectives of the CAD standards are as follows:

(a) To ensure that the CAD data files produced for project are co-ordinated and referenced in a consistent manner.

(b) 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.

(c) To standardise the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.

(d) To establish procedures necessary for the management of CAD data files.

(e) To ensure all contractors use 'Model space' and 'Paper space' in the production of their CAD files.

3.3 General

(1) 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.

(2) The intent of the issue of digital information is to aid the interface design by others.

(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.

(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.

(5) Any contractor or organisation making use of the CAD data from others shall be responsible for satisfying him that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it, provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

(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.

(7) Figured dimensions shall always be taken as correct where discrepancies occur.

3.4 Terminology and Associated Standards

(1) 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.

3.5 Paper Drawings

(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.

3.6 CAD Quality Control

(1) Random CAD Quality control audits will be carried out by Engineer on all CAD media received and transmitted.

(2) 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.

(3) In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place.

(4) A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

3.7 CAD Data Transfer Media and Format

(1) When CAD data is received and transmittal between the Engineer and the Contractor, the media shall be as follows:

(a) All CD-R/RW and DVD+/-R must be labeled on the data shield with:

i. Name of Company

ii. Project Title

iii. Drawing Filenames

iv. Disk No. / Total No. of disks

(b) All media shall be submitted with a completed form (CAD Disk)

(c) The CAD data file transmittal format required by from all contractors shall be in AutoCAD (version 2011) or latest version.

3.8 Revisions

(1) All 'Revisions', 'In abeyance' and 'Deletions' shall be located on a common layer which can be turned on or off for plotting purposes.

3.9 Block Libraries, Blocks and Names

(1) All construction industry symbols produced as CAD Cells shall typically conform to Indian Standards.

(2) All blocks created shall be primitive (i.e. NOT complex) and shall be placed absolute (i.e. NOT relative).

(3) 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.

(4) The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

(5) 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.

(6) 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.

3.10 CAD Dimensioning

(1) Automatic CAD Dimensioning will be used at all times.

(2) Any dimensional change must involve the necessary revision to the model space file.

(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.

3.11 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.

3.12 Global Origin, Location and Orientation on the Alignment Drawings

(1) Location or plan information in "Model Space" files shall coincide with the correct location and orientation on the project grid for each specific contract.

(2) 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 Eastings and Northings co-ordinates.

(3) The civil, structures and track Contractor(s) will establish the three setting out co-ordinates for their respective works, which will then be used by all other contractors including the Contractor.

3.13 Line Thickness and Colour

(1) 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**
Yellow	**2**	**0.35**
Brown	**34**	**0.5**
Blue	**130**	**0.7**
Orange	**30**	**1.0**
Green	**3**	**1.4**
Grey	**253**	**2.0**

3.14 CAD Utilisation of 2D and 3D Files

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualization process (i.e. architecture, survey and utilities).

3.15 CAD File Numbering

Contractor's CAD file numbering shall be as described in clause 2.1 above.

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APPENDIX - 8

TEMPORARY POWER SUPPLY

1 Introduction

The standard conditions applying to temporary power supply to any Works Area by the Contractor for its Site facilities are given under Clause 2 of this **Appendix**.

2 General

(1) The Contractor shall nominate a qualified electrical supervisor, whose name and qualifications shall be submitted in writing to the Engineer for review, who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site.

(2) The Contractor shall not install or operate any temporary electrical systems on the Site until this electrical engineer is appointed and has commenced duty.

(3) The name and contact telephone number of the qualified electrical engineer shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.

(4) The Contractor shall submit all base electrical circuits, characteristics and the details of the equipment for all temporary electrical installations, together with details of the temporary electrical equipment shall be submitted to the Engineer for his consent.

(5) All electrical installation work on Site shall be carried out in accordance with the requirements laid down in the Performance Specification and Indian standards.

(6) All work shall be supervised or executed by qualified engineers or suitably skilled and authorised electricians.

(7) Temporary electrical Site installations and distribution systems shall be in accordance with the rules and regulation applicable for and/or applied by:

a) The local electrical company supply rules;

b) Wiring regulations;

c) Distribution of electricity on construction and building sites;

d) Distribution assemblies for electricity supplies for construction and building sites;

e) Regulations for fire safety norms and requirements for civil works; and

f) Any other applicable Indian standards and regulations.

2.1 Materials, Appliances and Components

(1) All materials, appliances and components used within the distribution system shall comply with Indian standards.

2.2 Design Considerations

(1) Distribution equipment utilised within the temporary electrical distribution system shall incorporate the following features:

a) flexibility in application for repeated use;

b) suitability for transport and storage;

c) robust construction to resist moisture and damage; and

d) safety in use.

(2) All cabling shall be run at high level whenever possible and be firmly secured to ensure it does not present a hazard or obstruction to people and equipment.

2.3 Mains Voltage

(1) The Site mains voltage shall be as per the 400V/ 3 phases 4-wire system 50 Hz.

a) Single phase voltage shall be as per the 220V/240V supply.

b) Reduced voltages shall conform to Indian Standards.

(2) The following voltages shall be adopted for typical applications throughout the distribution systems:

a) Fixed plant – 400V/ 3 phase;

b) Movable plant fed by trailing cable – 400V /3 phase;

c) Installations in Site buildings - 220V/240V /1 phase;

d) Fixed flood lighting - 220V/240V 1 phase;

e) Portable and hand held tools – 12V, 24V or 36V /1 phase;

f) Site lighting (other than flood lighting) – 12V, 24V or 36V /1 phase; and

g) Portable hand-lamps (general use) – 12V, 24V or 36V /1 phase.

(3) When the low voltage supply is energised via the Indian Railway's power supply, any power utilised from that source shall be either 400V 3 phase or 220V/240V single phase as appropriate and the Contractor shall carry out any conversion that may be necessary to enable him to use power from that source.

(4) Protection of Circuits

a) Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults.

b) The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

c) Discrimination between circuit breakers, circuit breakers and fuses shall be in accordance with the Indian Standards.

2.4 Earthing

(1) Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

(2) Earthing systems shall conform to the following standards:

a) Wiring regulations;

b) Guide for safety in AC substation grounding.

2.5 Plugs, Socket Outlets and Couplers

(1) Low voltage plugs, sockets and couplers, as well as the high voltage couplers and 'T' connections shall be colour coded in accordance with, and conform to Indian Standards.

2.6 Cables

(1) Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required.

(2) Supply cables shall be in accordance with Indian Standards.

(3) For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to Indian Standards, as well as one of the following specifications appropriate to the duties imposed on it:

a) flexible cables for use at mines and quarries;

b) rubber insulated cables for electric power and lighting; and

c) insulated flexible cords and cables.

(4) Where low voltage cables are to be used, reference shall be made to Indian Standards, the following specifications shall also be referred to particularly for underground cables:

a) for armoured PVC insulated cables; and

b) flexible cables for use at mines and quarries.

(5) All cables which have a voltage to earth exceeding 65V (except for supplies from welding transformers to welding electrodes) shall be metal sheathed and/or armoured which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.

(6) Armoured cables having an over-sheath of polyvinyl chloride (PVC) or oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.

(7) For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in colour.

(8) Cables with an applied voltage to earth exceeding 12V but not normally exceeding 65V shall be insulated and sheathed with a general purpose or heat resisting elastomer.

(9) All cables that are likely to be frequently moved in normal use shall be flexible cables. Flexible cables shall be in accordance with Indian Standards.

2.7 Lighting Installation

(1) Where Site works are required during the night, the lighting circuits shall be run separate from other sub-circuits and shall be in accordance with Indian Standards.

(2) Voltage shall not exceed 55V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.

(3) Luminaries shall have a degree of protection not less than IP 54.

(4) In particularly onerous environments where the luminaries are exposed to excesses of dust and water, a degree of protection to IP 65 shall be employed.

(5) The Contractor shall provide a minimum lighting level of 200 lux by localised lighting in all areas where required for carrying out the works.

(6) Wherever a risk of damage may occur, luminaries shall be mechanically protected against impact damage by use of wire guards or other such devices.

2.8 Electric Motors

(1) Totally enclosed fan cooled motors to Indian Standards shall be used.

(2) Motor control and protection circuits shall be as stipulated in Indian Standards.

(3) Emergency stop switches shall be provided for all machinery.

2.9 Inspection And Testing

(1) Electrical installations on Site shall be inspected and tested in accordance with the requirements of the wiring regulations.

2.10 Identification

(1) Identification labels shall be affixed to all electrical switches, circuit breakers and motors to specify their purpose.

2.11 Maintenance

(1) Regular maintenance and checking of control apparatus and wiring distribution systems shall be carried out by a engineer or electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems.

(2) All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection and the recommended inspection period.

2.12 Metering

(1) The Contractor shall install and register a separately electrometer for each supplies of electricity from the applicable suppliers. The Contractor shall pay all required charges for the supplied electric power.

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APPENDIX - 9

PROJECT CALENDAR

1. THE PROJECT CALENDAR

(1) The Project Weeks shall be commenced on a Monday.

(2) A day shall be deemed to commence at 00:01 hour on the morning of the day in question.

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

(4) Requirements for the computation of Key Dates are given in Paragraph 3, **Part 2 "Employer's Requirement, Section V(A) , Volume 6,Appendix 2 – Work Areas and Contract Stages"**.

(5) A 7 day week calendar shall be adopted for various (Work) programme schedules for scheduling purposes, which shall also display the rest day and holidays.

(6) For Project purposes, the presentation shall be in 'Week"' units.

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APPENDIX 10

FIRST AID BASE

1. FIRST AID BASE

(1) First aid bases shall be located at each of the Contractor's principal Works Area and shall be made functional in all respect before commencement of physical work.

(2) The base shall consist of a treatment room fitted with two treatment couches, a hand wash basin, sterilising equipment and lockable cupboards to contain sufficient medical supplies for the Contractor's personnel, the Employer's personnel, the Engineer's personnel and the interfacing contractor working in the area and any visitors to the Site.

(3) In addition, two stretchers shall be stored, available for instant use.

(4) The first aid base shall contain a recovery room that shall be furnished with six chairs and a centre table.

2. STAFFING

(1) A qualified doctor shall be available on call during all times when work is being undertaken on Site.

(2) In each Site office and location at least one employee of the Contractor shall be trained in first aid and shall be available during all working hours for the purpose of attending to emergencies.

(3) The Contractor may conclude a contract with the local health centre where they are unable to implement any of the above services

3. EQUIPMENT

(1) A fully equipped ambulance and driver shall be available on call during all working hours.

(2) The ambulance shall be equipped with emergency life support equipment suitable for application in construction Site accidents.

(3) Portable first aid boxes will be maintained fully equipped at each of local Site offices.

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APPENDIX - 11

DESIGN CERTIFICATE

This Design Certificate refers to Submission No. ..…… which comprises:

[*Design Package No. .... / the Definitive 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 'Authorised Representative'

(for Designer)

Name

Position/ Designation

Date

CONTRACTOR'S CERTIFICATION

This is to certify that all design has been performed utilising 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 'Authorised 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 Definitive 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. ..……/

Definitive Design Submission No……/

Good for Construction Drawing Submission No. ..../

Technical Submission No. ..……/

Date of Issue of Notice of No Objection

(Delete as appropriate)*

The Contractor is required to provide this information in respect of each document in Section B

Section C

[Contractor to attach copies of necessary and required approvals]

APPENDIX - 12

SITE SAFETY PLAN

1. GENERAL

(1) The Contractor shall, within sixty (60) days of the Commencement Date, prepare and submit to the Engineer for review his proposed safety plan, as part of the Contractor's Safety, Health and Environment Plan, which shall contain as a minimum 2 to 15 items as mentioned in this **Appendix**.

(2) Procedures for updating the site safety plan and associated assurance system shall be given.

(3) The compensation for affected workers or their relatives shall be paid by the Contractor in such cases utmost expeditiously in accordance with the Workmen's Compensation Act.

2. STATEMENT OF THE CONTRACTOR'S SAFETY POLICY

(1) 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, declaring that the Contractor shall ensure that safety and industrial health are given priority consideration in all aspects of the Works and by the Contractor in discharging his contractual obligations;

(2) An understanding of and means of ensuring due compliance with the statutory regulations and standards relating to construction work in India;

(3) 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.

3. APPOINTMENT, DUTIES AND RESPONSIBILITIES OF SAFETY STAFF

(1) The safety staff and organisational structure, which should identify the personnel to be engaged solely for site safety assurance, the responsibilities of the participants and the subdivision of the site safety assurance tasks into elements which can be effectively controlled, technically and managerially.

(2) Names, addresses, telephone and facsimile numbers of all participants shall be listed where known (supplements to the site safety plan will update and complete this information);

(3) The powers vested in the safety staff, which shall be sufficient to enable them to take urgent and appropriate action to make safe the site and prevent unsafe working practices or other infringements of the safety plan or statutory regulations;

4. POLICY FOR IDENTIFYING HAZARDS

(1) The means by which the Contractor will identify hazards, assess the risks and develop procedures and method statements to minimise the risk for those risks which will occur during the works;

(2) The aspects of the Temporary Works design which should be communicated to the Engineer and others directly or indirectly associated with the Works if the installation of the associated works has a particular significance on the site safety of the Works;

(3) 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 minimisation of the risks associated with such hazards;

5. SAFETY EQUIPMENT

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.

6. CONTRACTOR'S EQUIPMENT

(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;

(2) Also regulations and procedures covering all safety and health aspects of the Works, including where appropriate but not limited to the following shall be produced by the Contractor:

a) housekeeping
b) working on or near operating railways
c) fire prevention precautions and fire fighting equipment
d) working in confined spaces
e) excavation
f) hot weather working
g) electrical equipment
h) welding/cutting operations and equipment
i) personal protection clothing and equipment
j) cranes
k) hoists
l) other lifting appliances
m) manual lifting
n) ladders
o) power tools
p) hand tools and portable power driven tools
q) hazardous substances
r) working at height
s) structural steel erection
t) lighting
u) protection against falling objects;

7. SUB-CONTRACTORS

(1) The means by which safety, rescue and industrial health matters and requirements will be communicated to sub-Contractors of all tiers and their due compliance with the site safety plan and all relevant statutory regulations is ensured by the main Contractor.

(2) The method by which the safety procedures and practices proposed by sub-Contractors will be reviewed for compliance with the site safety plan and statutory regulations including the provision of hazard and risk assessments and method statements.

8. DISCIPLINARY PROCEDURES

(1) 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. ACCIDENT REPORTING

(1) The Contractor's procedure for reporting and investigating accidents, dangerous occurrences or occupational illness;

10. SAFETY PROMOTION

(1) The Contractor shall provide details of the frequency, coverage and intent of site safety meetings together with the rationale for attendance.

11. SITE SECURITY

(1) The Contractor's system for the protection of authorised and unauthorised visitors to the site;

(2) The Contractor's proposals to ensure that construction methods do not compromise the Contractor's commitment to the site safety plan or its compliance with the statutory regulations.

13. 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 during the operation of the line.

14. LEGISLATION AND CODES OF PRACTICE

(1) The Contractor shall comply with all safety and industrial health legislation including, without limitation, the rules and regulation of the National Safety Council of India.

(2) The Contractor shall keep on the site copies of safety and industrial health regulations and documents.

(3) All regulations and documents referred in this clause shall be translated into languages which are understood by the operators and supervisors engaged by the Contractor or sub-Contractors and such translations shall be displayed or kept alongside those in English language.

15. SITE SAFETY PLAN

The brief outline of site safety plan shall cover the following:

15.1 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 programme 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.

15.2 Site Safety Inspections

(1) The Contractor will conduct site safety inspections at a regular frequency.

(2) The findings of the inspections shall be recorded on suitable forms which shall be kept available for inspection by the Engineer.

15.3 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.

15.4 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, shall 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.

15.5 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.

15.6 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 utilisation 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 utilisation 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.

15.7 First Aid

(1) The Contractor shall establish, maintain, staff, and fully equip a first aid base as detailed in **Part 2 "Employer's Requirement, Section V(A), Volume 6, Appendix 10 – First Aid Base"**.

15.8 Site Publicity

(1) The Contractor shall ensure that safety, rescue and industrial health matters are given a high degree of publicity to all persons regularly or occasionally on the site.

(2) Posters, in both Hindi and English, drawing attention to site safety, rescue and industrial health regulation shall be made or obtained from the appropriate sources and shall be displayed prominently in relevant areas of the site.

(3) These posters shall be changed on a monthly basis in order to ensure their continued impact.

(4) All personnel whether permanent, temporary or visitors will be given a site safety induction before they are allowed on to the site.

15.9 Training

(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.

(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.

(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.

15.10 Breach of Safety Regulations

(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.

(2) The due notice of this sanction shall be prominently displayed on the site.

15.11 Safety Devices

(1) All plant and equipment used on or around the site shall be fitted with appropriate safety devices which shall be operational at all times and shall be regularly inspected and tested.

(2) These shall include amongst others effective safety catches for crane hooks and other lifting devices.

(3) Functioning automatic warning devices and, where applicable, an up-to-date test certificate, for cranes and hoists.

(4) All plant and equipment used on or around the site shall be operated by suitably trained and qualified personnel with valid licenses from the appropriate authorities.

15.12 Testing and Certification of Lifting Gear

(1) The Contractor shall provide and maintain safe mechanical cranes, hoists and conveying facilities for the lifting and transport of materials and shall comply with all relevant codes of practice for safe use of cranes.

(2) All cranes, hoists and the like shall be fitted with audible overload warning devices.

(3) All such equipment shall be regularly maintained in accordance with manufacturers' recommendations and standards having regard to local legislation and recommendations from the appropriate statutory authority.

(4) Prior to use on site, all lifting appliances and lifting gear shall be tested to an approved safety margin and suitably identified in accordance with the requirements of the current legislation.

(5) The test certificate shall be submitted to the Engineer for review prior to the use of such equipment on site.

(6) The safe working load shall be clearly and indelibly marked on all lifting appliances and lifting gear either by stamping or by the addition of permanently secured tag labels.

(7) Stamping shall not be permitted on any stress-bearing part.

(8) The Contractor shall prepare and maintain an up-to-date register containing test certificates of all lifting and hoisting equipment used on the Works.

(9) The Contractor shall notify the Engineer of the person responsible for maintaining this register.

(10) The register shall, from the commencement of construction, be available on site for inspection by the Engineer and relevant authorities.

(11) Heavy plant or equipment which does not come under the jurisdiction of any local statutory legislation shall be subject to the testing and examination requirements as recommended by its manufacturer or in the absence of such, it shall be the responsibility of the Contractor to submit a standard or method of testing and examination to the Engineer for review.

(12) Competent operators with certificates certifying that the proposed operator has received training in the general principles of crane operation and specific training in the type of lifting or hoisting equipment he is required to operate shall be provided for the control of all lifting and hoisting equipment.

15.13 Fire Regulations and Safety

(1) The Contractor shall provide and maintain all necessary temporary fire protection and fire fighting facilities on the site during the construction of the Works, and shall comply with all requirements of the local fire services department.

(2) These facilities may include, without limitation, sprinkler systems and fire hose reels in temporary site buildings, raw water storage tanks and portable fire extinguishers suitable for the conditions on the site and potential hazards.

(3) The Contractor shall submit details of these facilities to the Engineer for review prior to commencement of work on the site.

(4) If, in the Engineer's opinion, the use of naked lights may cause a fire hazard, the Contractor shall take such additional precautions and provide such additional fire fighting equipment as the Engineer considers necessary.

(5) The term "naked light" shall be deemed to include electric arcs and oxyacetylene or other flames used in welding or cutting metals.

(6) Oxyacetylene burning equipment will not be permitted in any confined space. If required, the burning equipment of the oxy-propane type shall be used.

15.14 Electrical Safety

15.14.1 Interface with Indian Railway Operations

(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.

(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.

(3) Similarly, the site safety plan shall consider with other interfacing contractors in the closed vicinity of the Employer.

15.4.2 Safety measures while working in OHE area

(a) While working near the OHE area, as a maximum the safety guidelines as specified in para 20301, 20327, 20334, 20335, 20529, 20612, 20614, 20714, 20825, 20833, 21206 and 21207 of Volume II, Part 1 of AC Traction Manual of Indian Railways shall be followed

(b) No work close to the live OHE shall be carried out without power block and unless the work area is properly earthed and specific approval from Engineer / Employer

(c) A minimum distance of 2m shall be maintained between live OHE wire and any body part of the workmen or tools or metallic support etc.

(d) No electric connection shall be tapped from OHE.

15.4.3 Safety Requirements for Electrical Works

(a) 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.

(b) The LT/HT distribution diagrams of sub stations shall be prominently displayed. The substation premises, main switch rooms and D.B. enclosure shall be kept clean whenever works are carried either inside or outside.

(c) No flammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act

(d) Rubber insulating mats of suitable size and thickness should be provided in front of the main switch boards of sub-station or any other control equipments of medium voltage and above.

(e) 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.

(f) Necessary number of caution boards such as "Man working on line, Don't switch on"

shall be readily available in the vicinity of electrical installation.

(g) Standard first aid boxes containing materials as prescribed by the St. John's Ambulance Brigade or Indian Red Cross shall be made available.

(h) 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.

(i) No work shall be undertaken on live installations, or on installation, which could be energized unless one another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary

(j) No work on live L.T. bus bar or pedestal switch board in the sub stations should be handled by a person below the rank of a Licensed Wireman and such a work should preferably be done in the presence of a qualified engineer.

(k) 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.

(l) The electrical switch controls in distribution boards shall be clearly marked to indicate the areas being controlled by them.

(m) Before starting any work on the existing installation, it shall be ensured that the electric supply to that portion is cut off. Precautions, like displaying "Men at Work" caution boards on the controlling switches, removing fuse carrier from these switches shall be taken against accidental operation. Caution boards shall be kept with the person working on the installation.

(n) All electrical panels & switchgear shall conform to relevant Standard.

(o) All external enclosures shall have degree of protection not less than IP-54

(p) All equipment/system shall conform to relevant IEC standard on Electromagnetic Compatibility (EMC).

(q) Cable routes of all the newly laid cables by the Contractor shall be identified with concrete markers.

15.15 Standby Equipment

(1) The Contractor shall provide adequate stand-by equipment to ensure the safety of personnel, the Works and the public.

15.16 Co-operation

(1) 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. .

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APPENDIX - 13

TRAFFIC BLOCK (POSSESSION) MANAGEMENT

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 other adjacent civil, structures and track works contractors and the systems contractor as applicable and who will act as the traffic block coordinator for the Contractor only.

(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.

2. POSSESSION PERIODS

(1) The Contractor may use possessions on the line for execution of works as per approved plan following strict safety procedures.

(2) Line closures may be agreed subject to IR approval.

(3) The Employer gives no warranty that line closures and possession periods will be available during the period of the Works.

(4) The Employer will however provide any assistance necessary to the Contractor to enable him to obtain the line closures and possessions required by him for the Works but will not be responsible if any Possession requests are refused by IR.

(5) The Contractor shall prepare technological and organizational schedule for construction which shall include the work times in the weekends and during the dark part of the day.

(6) The Contractor shall submit his requests for ‘possessions’ at least fourteen (14) days earlier and inform IR at least 48 hours earlier if he is not able to use the permitted ‘possessions’.

(7) Any fees which may become leviable on account of track possessions required by the Contractor for permanent or temporary works shall not be payable by the Contractor. However, penalties, if any, levied by Indian Railways caused due to any careless working or otherwise of violation of the Terms and Conditions of the track possessions, shall be payable by the Contractor.

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APPENDIX - 14

DESIGN STANDARDS

Please refer to PART 2, SECTION V(B):PARTICULAR SPECIFICATIONS

APPENDIX - 15

ENGINEER'S ACCOMMODATION

1.0 GENERAL

1.1 The approximate number of Engineer's staff for Track & System Contract is expected to be about 40 including the Resident Engineers (RE). In addition, one room of similar specifications and facilities as Project Manager shall be provided for the Employer's Representative.

1.2 The System Contractor shall provide accommodation for the sole use of the Engineer and his staff, and the item of Engineer's Staff Compound shall comprise office for Project Manager and Resident Engineers and his staff.

Main Office	**Satellite Office**
Office for the Project Manager, Resident Engineers (4 Nos.) and Other Officials (approx.. 20 Nos.) (Office and suitable Resting Facilities)	Office for the Engineer's Other Officials (approx. 10 Nos.) (Office and suitable Resting Facilities)

1.3 Any modification/adjustment/change between main office and satellite office if required should be done in consultation with the engineer and employer.

1.4 The main staff compound shall be sited adjacent to but separate from the Contractor's main Site offices, in a compound established by the Contractor.

1.5 The Contractor shall provide and properly maintain fully-furnished, serviced, cleaned, equipped and air-conditioned/cooled staff compound and satellite staff compounds for the Engineer, his staff and the Employer's representatives. The compounds shall be properly fenced for safety and security. The plans for each compound shall be designed/ arranged by the Contractor and forwarded to the Engineer for approval prior to construction.

2.0 FACILITIES - MAIN STAFF COMPOUND

The Engineer's offices shall have a minimum plan area of 400 m^2 for the Main Office and satellite office.

2.1 Room requirements

The Main and Satellite Offices will require providing the office space for following Engineer's staff :

1) Project Manager
2) Resident Engineers – 4 Nos.
3) Employer's Representative
4) Field Engineers
5) Design Experts
6) Safety officer / Engineer
7) Quantity Surveyors
8) Administrative Assistant

In addition, the accommodation at these locations will be required for the following facilities:

1) Guest Room
2) Conference room sufficient to seat 20 persons
3) First Aid room
4) Other facilities (kitchenette / messing facilities, adequate WCs and showers, two storage rooms, changing room)

2.2 At the Engineer's main and satellite staff compounds, the Contractor shall provide hard covered sheds sufficient for twenty (20) Engineers/ Engineer's visitors' vehicles respectively.

3.0 GENERAL REQUIREMENTS

3.1 Materials used for the construction of the offices shall be of good quality and finish. Materials shall be chosen such that the buildings when erected shall give good heat and sound insulation. Both external and internal walls shall be sound proof.

3.2 Windows to each room shall be of an area not less than 10% of the wall area. All windows to ground floor offices shall be fitted with burglar bars firmly attached to the structure of the building. All windows shall be fitted with mosquito netting. All windows shall be fitted with venetian blinds.

3.3 Internal doors shall be hollow core flush doors and shall be fitted with door closers, lever latches, mortise lock and keys.

3.4 External doors shall have barrel bolts both at top and bottom of one leaf and a Yale lock on the other leaf. External doors shall be of solid external quality and hung with heavy-duty hinges. All sets of keys shall be delivered to the Engineer.

3.5 All buildings shall be supplied with continuous (24 hour) running potable water to the kitchens and wash rooms. The toilets may use raw water for flushing, shall be equipped with water closets and sitting type stools and shall be adequately ventilated. The Contractor shall also arrange for the constant and hygienic disposal of all effluent, sewage and rubbish from the buildings. Storage tanks will be required due to restricted water supply at most locations.

3.6 All buildings shall be supplied with electricity at 220 voltage and 50 Hz that shall be distributed to each room in accordance with the regulations. Lighting and electrical power points shall be provided in each room. The disposition and location of light and power points will be as directed by the Engineer. A backup generator is required to be provided to meet the full power load in case of power disruption.

3.7 Each kitchen shall be provided with worktops, a 2 drainer stainless steel double sink, cupboards beneath the worktop and mounted on the walls, a cooker with 2 gas rings and a microwave oven and a 200 L refrigerator. Tea/Coffee making facilities for 20 persons shall be provided. Tiling shall be provided to the walls above the kitchen table top.

3.8 Fire fighting equipment shall be provided in accordance with the recommendations of the local fire brigade station.

3.9 Offices shall be at location agreed by the Employer.

3.10 In case the contractor wants to hire the Engineer's accommodation, it can be done with the approval of the Engineer. However, the facilities mentioned in this appendix shall be provided.

3.11 The office accommodation shall be retained until the expiry of the Defects Notification Period unless otherwise instructed to the contrary by the Engineer.

3.12 Prior to commencing the erection of the Engineer's accommodation the Contractor shall obtain the consent of the Engineer to the accommodation, including layout, equipping, electrification plan and furnishings proposed by the Contractor.

3.13 The Contractor shall make such reasonable amendments to the layout and furnishings as the Engineer may request.

3.14 Till such time System Contract is in place, the Consultant shall hire the office accommodation for which separate monthly lump sum payment will be made by Employer to the Consultant.

3.15 Unless otherwise permitted by the Engineer, the Contractor shall complete the accommodation and provide all equipment and furnishing in time to allow the Engineer to occupy the offices prior to the commencement of excavation or any Permanent Works. Till such time the Engineer's accommodation is ready for occupation, the contractor shall hire alternate sufficient space for the office accommodation for the Engineer. The accommodation shall be maintained in a clean, stable and secure condition and shall be cleaned at least daily.

3.16 Equipment provided for the use of the Engineer shall be maintained in a clean and serviceable condition and all consumables shall be replenished when required.

3.17 Measuring and testing equipment shall be calibrated before they are used and at regular intervals to which the Engineer has given his consent.

3.18 Survey equipment shall be maintained by the service agent and shall be regularly checked but the overall responsibility shall rest with the Contractor.

3.19 Equivalent replacements shall be provided for equipment which are not in working order or otherwise are not in a serviceable condition or are being repaired or serviced.

3.20 The consent of the Engineer shall be obtained before accommodation or equipments are removed.

4.0 FURNITURE & EQUIPMENT

The Contractor shall supply the new furniture and equipment to the Engineer's offices in the manner required by the Engineer. Given below is the indicative list of items required for Engineer's office in the main and satellite subsidiary compounds.

S.N	Description
	General Office Requirement
1.	Conference table (size = 2000mm x 800mm)
2.	Conference chairs
3.	Glass-fronted lockable bookcase
4.	Double pedestal desk (size1500 mm x 900 mm)
5.	Single pedestal desks (size 1200 mm x 900 mm)
6.	Swivel office chair with armrests
7.	Swivel office chair without armrests
8.	Typist chair
9.	Visitors chair
10.	3-shelf bookcase
11.	4-drawer filing cabinet
12.	Plan chest (A1 size)
13.	Tables (size 1500mm x 900mm)
14.	lock-able cupboard 6 ft high with internal shelves
15.	AO size drawing hanger for 1000 drawings
16.	A0 Digital document System (Xerox 8830 DDS or similar) capable of printing, scanning, copying, reduction and enlargement in RE Office
17.	Floor mounted safe (size – 750mm x 450mm x 600mm)
18.	First aid kits for up to 30 persons
19.	Safety helmets
20.	Safety harness
21.	Pairs steel toed construction boots sizes to be advised

S.N	Description
22.	Day glow waistcoat
23.	Pairs steel handling gloves
24.	Pairs industrial safety goggles
25.	Potable water dispenser with hot/cold taps and paper/plastic cups
26.	15 piece dinner service
27.	Fire extinguishers

5.0 PERSONNEL

In addition to the above listed items, the Contractor shall supply the following personnel for full duration of contract-

a.	Field / Office Attendants	6 No
b.	Drivers	As per Vehicle Provisions
c.	Messengers	2 No
d.	Watchmen/Security Guard	2 No (24 x 7)

6.0 TRANSPORT FOR THE ENGINEER

6.1 General

The Contractor shall provide road transport as described in this document for the use of the Engineer and his personnel.

6.2 Road Transport

(i) The vehicles shall be new and delivered and maintained by the Contractor in good roadworthy condition. The vehicle shall be replaced with a new vehicle after a maximum run of 100,000 km or Three years, whichever is earlier.

(ii) The vehicles shall be licensed and insured for use on the public highway and shall have comprehensive insurance cover for any qualified driver authorized by the Engineer together with any authorized passengers and the carriage of goods or samples.

(iii) The Contractor shall provide fuel, oil and maintenance in conformity with the vehicle manufacturer's recommendations and all relevant toll and parking charges incurred in connection with the Works. The vehicles provided under this Contract are likely to log an average of 3,500 km and 300 hours/per month (the average will be worked out considering all the vehicles provided by the Contractor and operated over a period of six months).

(iv) The vehicles shall be provided by the Contractor for use of the Engineer during the day or night as required by the Engineer.

(v) The Contractor shall organize daily cleaning of the vehicles from inside and outside as required during the currency of the Contract.

(vi) In case of any defect requiring major repairs and grounding of the vehicle for more than 24 hours, a suitable replacement shall be provided by the Contractor for such vehicle. In case the Contractor fails to provide vehicle(s) or substitute vehicle(s) [In case of grounding of vehicle for over 24 hours] the same shall be arranged by the Engineer from other source. An amount of Rs. 2,000 per day for each vehicle (that the Contractor has failed to provide) or as per actual, whichever is higher, shall be recovered from the Contractor.

(vii) The Contractor shall employ and make available competent drivers fully licensed to operate the vehicles as and when required by the Engineer and his personnel. The Contractor shall replace drivers at the request of the Engineer.

6.3 Type of Vehicles

The Contractor shall provide the following vehicles of each type as and when directed by the Engineer:

Type		Employer, Engineer and his personnel (Vehicle months)
Type A	Air-conditioned four wheeled vehicle of a type and colour approved by the Engineer and having no trade name displayed except the name of the Manufacturer of the vehicle. The vehicle shall have an engine capacity of at least 1800 cc and have at least 4 seats	144 vehicle months.
Type B	Non-air conditioned Tata Sumo or similar type vehicle with seating capacity of not less than 5 seats	324 vehicle months.

Note:

1. The vehicles will be mobilized as per the approval of the Employer so that pooling for vehicle utilization can be availed.

2. After the consumption of above provisioned vehicle months, these may be varied after due determination of Engineer as variation of Contract agreement and approval of Employer up to completion of contract.

6.4 Transport Requirements

Transport for the, Engineer and his Personnel shall be provided as per the mobilization of the PMC Team for field work from Project Office.

6.5 Records

Records of journeys shall be kept in logbooks signed by the Employer, Engineer and their personnel. Records shall include details of the times and purpose of journeys with appropriate odometer readings and distances travelled. The person using the transport or authorizing the journey shall sign against the log book entries. Logbooks shall be presented for inspection when required by the Engineer and all completed logbooks shall be handed over to the Engineer.

7.0 For defect liability period of 24 months vehicle for consultant will be provided by Employer.

8.0 Vehicles for PMC shall be provided by Employer till such time System Contract is not in place.

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BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, INSTALLATION OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMPSUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA-NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

SYSTEM WORKS CONTRACT PACKAGE
Issued on: 29.12.2017

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

EMPLOYER'S REQUIREMENT

Part -2, Section-V(B), Volume-7

Particular Specifications-Signalling Works

EMPLOYER:

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD

(A GOVERNMENT OF INDIA ENTERPRISE)

Under

MINISTRY OF RAILWAYS

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Objective

1.1.1 The objective is to design, build, install, test and commission a safe and reliable Signalling system for Mughalsarai- New Sonnagar & New Chiraillapathu (Excluding New Durgauti - New Karwandiya Section) section of EDFC.

1.1.2 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 manned by Station Masters.

1.1.3 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.

1.1.4 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.

1.1.5 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.

1.1.6 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.

1.1.7 It is an objective of this contract to ensure that the environmental impact associated with the Signalling works is minimal.

1.1.8 It is an objective of this contract to minimize the energy cost. The Signalling system shall be designed for minimum energy consumption.

1.1.9 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.

1.1.10 It is an objective of this contract to ensure that Signalling and telecommunication system shall be compatible with the existing S&T system in New Durgauti- New Karwandiya section of DFCCIL.

1.2 Signalling Overview

1.2.1 The entire stretch from New ERC Mughalsarai to New Sonnagar and New Chiraillapathu 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.

1.2.2 The lines connecting DFCCIL Junction stations to IR stations shall be provided with Absolute Block working/Slot working.

1.2.3 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 Telecommunication.

1.2.4 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 Telecommunication.

1.2.5 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.

1.2.6 Traffic controllers at OCC at Allahabad will manage overall train operations, the operations at local level will be managed by Station Masters located at the stations in 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.

1.2.7 The 'Traction Power SCADA Control system' with Video wall for display of SCADA system as well as the SCADA Channels shall be provided by system contractor for this section. Contractor shall ensure the integration of the SCADA Control system with the existing system at OCC (Allahabad).

1.2.8 System Contractor will provide 230V power supply for the Signalling system at all locations. The Bidders are requested to determine their 230V power supply requirements in accordance with Para 6.2 & 6.3 of this specification.

1.2.9 The Signalling system shall be housed in Signal Equipment Rooms (SER). SER at New Sonnagar Station will be constructed as part of Station building under CST contract package, whereas other stations (New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Chiraillapathu),LC Gate Goomties and Auto Location Huts (ALH)for housing Signalling and Telecommunication equipment at station, LC Gates and in the Block sections shall be provided by system contractor. The number, size and location of Station building structure, LC Gate Goomties and ALH shall be determined by the system contractor's design.

1.2.10 Communication of control signals for both Signalling and Telecommunications shall be distributed via an Optical Fibre Data Transmission network.

1.3 Employer's Requirement –Scope of Works

1.3.1 The Signalling system scope is comprised of the following:

1.3.1.1 Design and implementation of the Signalling works including Electronic interlocking and power supply arrangements at five junction stations viz New ERC (East receiving cabin)-Mughalsarai Phase I & final Phase, New Ganjkhwaja, New Sonnagar-Phase I & Phase-II & New Chiraillapathu along with one DFC junction station at New Sonnagar Link and interfacing of S&T works at New Durgauti and New Karwandiya stations (under commissioning by DGON-KWDN system contractor).

a. As per the approved ESP, the connectivity between DFCCIL Lines and IR lines at ERC-Mughalsarai (IR) is considered as Phase-I work. The connectivity of DFCCIL lines of this section with the APL-2 DFCCIL lines at New Mughalsarai yard is considered as the final phase work.

b. As per the approved ESP Phase-I of New Sonnagar, the connectivity between DFCCIL Lines and IR lines at BagahBishunpur (IR) is considered as Phase-I work. As per approved ESP phase-II of New Sonnagar, the connectivity of DFCCIL lines of this section with IR lines at BagahBishunpur with third line is considered as phase-II work. The existing BagahBishunpur IR yard is having 5 lines with double line (UP,

DN) electrified section. The proposed BagahBishunpur IR yard will be of 7 lines with triple line (UP, DN & Reversible line) electrified section.

1.3.1.2 Design and Implementation of Absolute Block/Slot working on single/Double lines connecting DFCCIL and IR stations viz. New ERC Mughalsarai to ERC Mughalsarai, New Ganjkhwaja to Ganjkhwaja (IR), New Chiraillapathu to Chiraillapathu (IR) and New Sonnagar to BagahaBishunpur (IR) and New ERC-Mughalsarai to APL2 section at New Mughalsarai.

1.3.1.3 Design and Implementation of Automatic Signalling in a continuous stretch on DFCCIL Main lines from Mughalsarai– New Sonnagar–New Chiraillapathu section (Excluding New Durgauti-New Karwandiya).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.

1.3.1.4 Design and Implementation of the Interlocking of existing 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-3**.

1.3.1.5 Design and Implementation of a Train Management System (TMS) for supervision, management and monitoring of train traffic on the Mughalsarai- New Sonnagar & New Chiraillapathu section. This shall include the provision of Video Wall Display for Signalling and SCADA system for Mughalsarai to New Sonnagar & New Chiraillapathu including New Durgauti- New Karwandiya section. All interfacing work at existing EIs of New Durgauti – New Karwandiya Section of DFCCIL shall also be done by system contractor for exchanging information from EIs through appropriate communication interface in respect of train management system works.

1.3.1.6 Design and implementation of Service & Diagnostic (S&D) system for monitoring and supervision of health of Signalling equipment and its power supply.

1.3.1.7 "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.

1.3.1.8 All associated works required for satisfactory completion of works as defined in this Particular specifications.

1.3.2 Contractor's Responsibility for Discrepancy

1.3.2.1 All designs and drawings submitted by the contractor shall be based on a thorough study and shall be such that the contractor is satisfied about their suitability. The Engineer's approval will be based on these considerations, notwithstanding the approval communicated by the Engineer, during the progress of the contract for designs and drawings, prototype samples of components, materials and equipment after inspection of materials, after erection and adjustments to installations. The ultimate responsibility for correct design and execution of work shall rest with the contractor.

1.3.2.2 The contractor shall be responsible for and shall bear and pay the costs for any alteration of works arising from any discrepancies, errors or omissions in the design and drawings supplied by him, whether such designs and drawings have been approved by the Engineer or not.

1.3.3 Deployment of Key Personnel for signal & telecom work at site

System contractor shall ensure deployment of key personnel as per the list given in Part 1, Section III Clause 2.2 of requisite experience and qualification (minimum graduate in relevant field) during the execution of the work in addition to semi-skilled and skilled staff.

1.3.4 Antitheft Arrangement

1.3.4.1 Suitable Antitheft arrangement should be provided for MSDAC Field DP, Location Boxes, Point Machine, MF Earth Electrode etc.

1.3.4.2 Antitheft arrangement shall be aesthetical design and robust. The final deisgn shall be submitted to Engineer for approval.

1.4 Communication System:-

1.4.1 The Details of Communication System is given in separate Particular Specification - Telecommunication Works.

1.5 Relevant Documents

1.5.1 This Particular Specification (PS) shall be read in conjunction with the General Conditions of Contract (GCC), Particular Conditions of Contract (PCC) 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 the PS, the requirements of the PS shall prevail.

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

a Employer's Requirements–Particular Specification
b Employer's Requirements–General Specification
c Indian Railway General Rules.
d. Indian Railway Signal Engineering Manual
e Indian Railway Telecom Manual
f Indian Railway Standard Specification(IRS specification).
g RDSO Draft Standard specification(RDSO SPN specification).
h International Standards referenced herein.
i Other National Standards
j Other International Standards.

1.6 Implementation of Work:

1.6.1 The Contractor shall coordinate with CST contractor for detailed interface requirements on the railway route alignment and mainline track layout in accordance with Employer's Requirements and other design criteria. Also it will coordinate for interfacing with the system contractors of the adjoining sections of EDFC. At junction station and LC Gates where there is interfacing with IR is required, contractor will coordinate with IR.

1.6.2 The Signalling System's electronic equipment shall be designed and supplied for a Design Life of 20 years and associated wayside equipment shall be designed and supplied for Design Life of 30 years. The contractor is required to supply latest version of Signal & Telecom equipments as per the latest guidelines issued from RDSO at the time of procurement.

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

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

1.6.5 Signalling and telecommunication system shall be compatible with the existing S&T system in New Durgauti- New Karwandiya section of DFCCIL.

1.7 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 fact or not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters shall lie with the Contractor development.

*****End of Chapter*****

2. DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

2.1.1 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.

2.1.2 Auxiliary signals: Shunt signals – Independent or below Main signals, Calling-on signals, Route indicators, 'A' marker & 'AG' marker lights for Semi-Automatic signals.

2.1.3 Control Terminal: An Industrial grade computer complete with hard disc, VDU display monitor, key board and mouse, provided with SM.

2.1.4 Design life: The design life is the period of time during which the system is expected to work satisfactorily within its specified parameters.

2.1.5 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.

2.1. 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.

2.1.7 Fouling Point: The position at the convergence of two tracks where the kinematic envelopes, one on each line, would come into contact.

2.1.8 Graceful Degradation: The transfer in quality **or performance** from the initial level to a lower operable level.

2.1.9 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.

2.1.10 Independence: The isolation between the investigating technician undertaking the work and a second person for example, responsible for checking or approving the work.

2.1.11 Level Crossing: Is the rail – road surface crossing.

2.1.12 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.

2.1.13 Main running signals: Home signal, Starter signal, Intermediate Starter signal, Advance Starter signal and Gate signals.

2.1.14 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.

2.1.15 Mean Time Between Failures (MTBF): The average time between failures causing service delays for a piece of equipment, a system or a subsystem.

2.1.16 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.

2.1.17 Reliability: The probability that an item/equipment/system can perform a required function under given conditions for a given time interval.

2.1.18 Running Lines: The DFCCIL Running lines between New ERC Mughalsarai and New Sonnagar & New Chiraillapathu.

2.1.19 Safety: Freedom from unacceptable risk.

2.1.20 Sub system: Each system comprising Signalling system. E.g. EI sub system, TMS sub system.

2.1.21 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.

2.1.22 TMS terminal: A terminal having MMI device with video display unit (VDU), Keyboard and mouse.

2.1.23 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.

2.1.24 Track Section: A Section of track between two DPs used for controlling the signal depending upon its clearance or otherwise.

2.1.25 Video wall: A graphical representation of the railway and its global operating status.

2.1.26 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.

2.1.27 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.

2.2 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 (Committee European 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 / Reliability, Availability, Maintainability
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*****

3. General Requirements

3.1 Basic Design Philosophy and Requirements

3.1.1 Proven Design

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

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

c Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered Sub-system.

3.1.2 The design philosophy should meet the following criteria:

a Application of state-of-the-art Technology
b Service proven design.
c The minimum design life of mainline electronic equipment and the associated way side equipment is 20 years and 30 years respectively
d Minimum life cycle cost
e Ease of maintainability
f Use of interchangeable, modular components
g Extensive and prominent labeling of parts, cables and wires
h Use of unique serial numbers for traceability of components
i High reliability
j Energy efficiency
k System safety
l Adequate redundancy and factor of safety
m Use of fire retardant materials for On board wiring
n Environment friendly
o Adherence to technical specifications.
p Open Architecture for integration with other Systems
q Ease of expansion and integration.
r Protection against theft/pilferage.

3.1.3 Adequate margin shall be built into the design particularly to take care of the environmental considerations prevailing at the location of the project.

3.1.4 All Signalling and Train Control system designs of hardware and software shall be prepared by experienced Signalling Engineers. All Signalling system installation, testing and commissioning shall be executed by well trained and qualified engineers under the leadership of an experienced Signalling testing manager.

3.2 Design Principle

3.2.1 Signalling system shall be designed as per the requirement of Indian Railway General Rules and Indian Railway Signal Engineering Manual.

3.2.2 Firstly, system contractor shall plan, design, drawing and execute all the S&T work including LC gate common items (cabling, analog and digital requirement etc.) of entire section considering standard automatic signal block working with keeping the additional provision of LC Gate Signals & track detection system etc. (if any) in design and drawing except exclusive physical work of interfacing, indoor & dependent outdoor work of each LC gate. However, LC gate locations (Chainage etc.) may be used as reference for design and drawing purposes at this stage.

3.2.3 All interfacing S&T cables with IR & DFCCIL and other items pertaining to each LC gate shall be identified and secured at adequate distance from it to avoid damage during construction of ROB/RUB and readily available for extension at LC gate/LC gate goomty /IR at later stage for execution of LC gate interlocking when interfacing issues sorted out. It shall be done as per approval of Engineer.

3.2.4 In due course of time and subsequent finalization of interfacing issues (ESPs & other issues etc.) with IR of each LC gate, all work at LC gate viz. design & drawing for LC, Construction of LC gate goomtys, IPS & Battery, ELB, sliding booms, LC interlocking, approach locking, warning, auto changeover at LC gate Lodge, ATs, Road signals, physical interfacing work with IR & DFCCIL, Domino Panel and modification in the approved plan, design and drawing etc. as stated above Para-3.2.2 shall be done.

3.2.5 S&T structures and cabling of signal & telecomm cables near LC gates shall be planned & executed in such a way that during elimination of LC gates by ROB/RUB etc., interruption in S&T working shall be minimum. Before execution, required design & drawing plan are to be approved by Engineer.

***** End of Chapter *****

4. Project Design Standards

4.1 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.

4.1.1 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
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

SPECIFICATION NO.	DESCRIPTION
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/176/2013 Ver3.0	Multi Section Digital Axle Counter
RDSO/SPN/177/2012 Ver3.0	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 RDSO/SPN/192/2011	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
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:

SPECIFICATION NO.	DESCRIPTION
	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
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

SPECIFICATION NO.	DESCRIPTION
	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
ISO 11064 Parts 1-7	Ergonomics Design of Control Centres

4.1.2 Following manuals and schedules shall also be referenced during the design:

(1) Indian Railways Signal Engineering Manual (IRSEM).

(2) Indian Railway Telecom Manual

(3) General Rules (GR) of DFCCIL/IR.

(4) AC Traction Manual (ACTM) of IR.

(5) Indian Railways Permanent Way Manual (IRPWM).

(6) Schedule of Dimensions (SOD) of Eastern Corridor of DFCCIL.

4.2 Procurement

4.2.1 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.

4.2.2 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.

4.2.3 Designated equipment shall be procured from RDSO's "Approved list of firms for manufacture and supply" and as per relevant IRS/RDSO specifications. Point machine

with corresponding ground connections to suit canted points (1 in 20 cant turn outs) with thick web switches shall be got approved from RDSO/Employer. If any equipment other than covered above is proposed to be supplied, then the same must be proven being in regular use and having established its satisfactory performance over a period of at least two years during last 5 years on the World wide Railway/Metro system. Details of the same should be submitted well in advance for review and approval by the Engineer

*****End of Chapter*****

5. Performance Requirements

5.1 System Performance

5.1.1 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.

5.1.2 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:

5.2 Reliability, Availability, Maintainability (RAM)

5.2.1 The Signalling system shall achieve all RAM requirements specified in GS and this PS.

5.2.2 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.

5.2.3 All the sub-systems and equipment to be used for this system shall be of proven design, in use on other similar railway/ DFC project and reliability in accordance with RAMS standards.

5.2.4 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.

5.2.5 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.

5.2.6 Recovery: Provision shall be made to recover from any credible fault while minimizing disruption to service.

5.2.7 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.

5.2.8 The Contractor shall submit system Reliability, Availability and Maintainability (RAM) Plan for review and approval of the Engineer.

5.3 Reliability Modelling

5.3.1 The Contractor shall perform Reliability and Maintainability analysis of each system, up to the point of interface with other systems.

5.3.2 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.

5.3.3 The reliability model consisting of reliability block diagrams and probability of success equations shall be developed and submitted to the Engineer for acceptance.

5.3.4 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.

5.3.5 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.

5.4 Failure Definitions

5.4.1 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.

5.4.2 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.

5.4.3 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.

5.4.4 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.

5.4.5 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.

5.5 Reliability Requirements

5.5.1 Reliability requirements and goals shall be developed in terms of Mean Time between Service Affecting Failures (MTBSAF)/ Mean Time Between Failure (MTBF).

5.5.2 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.

5.5.3 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.

5.5.4 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.

5.5.5 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 6.1.5 of this specification.

5.5.6 The Contractor shall minimize the risk of common mode faults in design of the subsystems providing redundancy.

5.5.7 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.

5.6 Availability

5.6.1 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.

5.6.2 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.

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

5.6.4 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
Track Vacancy Detection System (MSDAC/SSDAC, power supply, etc.)	99.99%	Availability per system
Train Management System	99.98%	Availability per system

5.6.5 Degraded performance or loss of any software or hardware dependent function of any end equipment shall be taken as unavailability.

5.7 Perturbation Analysis

5.7.1 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.

5.7.2 The service interruption analysis shall document all failure modes capable of causing service interruptions.

5.7.3 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.

5.8 Maintainability

5.8.1 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.

5.8.2 The system shall be designed such that the MTTR shall be less than one hour.

5.8.3 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.

5.8.4 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.

5.8.5 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.

5.8.6 The System shall be suitably designed to minimize the need for frequent preventive maintenance.

5.8.7 Redundancy shall be used to enable any necessary preventative maintenance to be carried out on off-line systems during Traffic Hours.

5.8.8 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.

5.8.9 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.

5.8.10 **Service Life support**

5.8.10.1 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.

5.8.10.2 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.

5.8.10.3 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.

5.8.10.4 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.

5.9 Line Replacement Unit (LRU)

5.9.1 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.

5.9.2 Incorrect installation or incorrect attachment of any LRU to be prevented through mechanical design.

5.9.3 The System shall be designed to ensure that any components which are physically interchangeable but not functionally interchangeable cannot operate in the System.

5.9.4 LRU electrical connections shall be formed by using plugin units as far as practicable.

5.9.5 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.

5.9.6 The System shall maximize the use of remote means to conduct maintenance, fault finding and fault rectification activities and to access maintenance information.

5.9.7 The Signalling System shall display all detected failures on the S&D terminal at the Station and in the OCC.

5.9.8 Fault indications should clearly indicate which LRU is affected and the degree of the failure and loss of functionality.

5.9.9 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.

5.10 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.

5.11 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.

5.11.1 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.

5.11.2 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.

5.11.3 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

Category	**Description**
	expected to occur.
Improbable	Unlikely to occur but possible. It can be assumed that the hazard may exceptionally occur.
Incredible	Extremely unlikely to occur. It can be assumed that the hazard may not occur.

(3) The hazard severity is categorized into different hazard consequence levels:

Hazard Category	Consequence	Description
4	Catastrophic	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.
3	Critical	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.
2	Marginal	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage. Acceptable with adequate control and agreement of the Employer.
1	Negligible	Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

(4) Risk classification of hazards:

Frequency		Consequence			
		Catastrophic (Category 4)	Critical (Category3)	Marginal (Category2)	Negligible (Category1)
Frequency	Frequent	I	I	I	II
	Probable	I	I	II	III
	Occasional	I	II	III	III
	Remote	II	III	III	IV

	Improbable	III	III	IV	IV
	Incredible	IV	IV	IV	IV

(5) The Risk Classes are defined as follows:

Risk Class		Interpretation
Class I	Intolerable	Intolerable risk. Shall be eliminated
Class II	Undesirable	Undesirable risk, and tolerable only if risk reduction is impracticable of if the costs are grossly disproportionate to the improvement gained. Shall only be accepted when risk reduction is impracticable and with the agreement of the Railway Authority or the Safety Regulatory Authority, as appropriate
Class III	Tolerable	Tolerable risk if the cost of risk reduction would exceed the improvement gained. Acceptable with adequate control and with the agreement of the Railway Authority.
Class IV	Negligible	Negligible Risk. Acceptable with/without the agreement of the Railway Authority

(6) Risk acceptance shall be based on the principles of "As Low as Reasonably Practicable" (ALARP) and as follows:

(a) Category 4 hazards shall be 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

5.11.4 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 behavior.

(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.

5.11.5 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.

5.11.6 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.

5.11.7 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.

5.11.8 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.

5.12 RAM Demonstration

5.12.1 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.

5.12.2 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.

5.12.3 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.

5.12.4 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.

5.12.5 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.

5.13 Environment

5.13.1 Details of climatic conditions generally prevalent in Mughalsarai-Sonnagar section are givenin Part 2 "Employers Requirement, Section V (A), Volume 2, Para 18.

5.13.2 The Signalling Equipment rooms in OCC are provided with air-conditioning by 'Other contractors'. After installation of equipments at OCC for this section by system contractor, if additional air conditioning is required at OCC then it shall be provided by this system contractor.

5.13.3 The station building at New ERC-Mughalsarai, New Ganjkhwaja, New Sonnagar Link & New Chiraillapathu, Auto location huts/Telehuts & LC gate Goomty which are being constructed by system contractor, shall provide suitable ventilation system with redundancy (1+1) to regulate temperature and maintain air circulation within limits. The contractor shall provide Air-conditioning in Signal equipment room, telecom equipment room, ASM room and, wherever necessary for environment control or for improvement of

reliability of specific Signalling equipment or its power supply or as approved by Engineer.

5.14 EMC/EMI Requirements

5.14.1 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.

5.14.2 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.

5.14.3 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.

5.14.4 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.

5.14.5 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.

5.14.6 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.

5.14.7 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.

5.14.8 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.

(7) Cabling may be done as per provision of Para 3.2 of this PS.

5.14.9 The latest versions of IEC61000-5 and other relevant standards shall be complied with wherever applicable.

*****End of Chapter*****

6. TECHNICAL SPECIFICATIONS

6.1 Signalling System Requirements

6.1.1 General

(1) Automatic Signalling shall be provided on Main lines in a continuous stretch from New ERC Mughalsarai to New Sonnagar and New Chiraillapathu 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 with latest amendment or Block proving by Axle Counter using UFSBI as per RDSO spec. IRS: S105/2012 with latest amendment. 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 signaled 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).

(7) All level crossing gates shall be provided with Electric lifting barrier and interlocked wherever Level crossing gates serve both DFCCIL and IR tracks together. The work shall be suitably coordinated with IR.

6.1.2 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, Starter and Intermediate Starter signals on extended loops of Junction / Crossing 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 with latest amendment 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 with latest amendment. 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 with latest amendment 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 with latest amendment 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).

(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) SuitableEarthing arrangements shall be provided for all signals.

(3) **Foundations for Signals**

(a) All signals shall have concrete foundation having a minimum grade of M20.

(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.

6.1.3 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/192/2005Ver 1.0 with latest amendment or RDSO/SPN/203/2011 with latest amendment or latest 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 with latest amendment 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 card when added in future utilizing available spare provisions as indicated at Para 6.1.3.(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) Sectional route release with train passes through the route set;
(iv) Approach locking after route cancellation when train approached the set route (including gate signals); and
(v) 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 25% of the I/O card 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 6.1.1(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 up to 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 up to 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 authorize 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.

6.1.4 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 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 6.1.4(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 and colour VDU monitor of suitable size of minimum 42".

(c) The Software of Control terminal shall be validated to SIL-2. All safety critical functions shall be compliant to SIL-4.

(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 backup of 4 hours by providing a separate UPS system at station.

6.1.5 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/176/2013 Ver3.0 with latest amendment & manufacturer's specification and procured as per Para 4.2 of this specification.

(c) Single Section Digital Axle Counter (SSDAC) as per RDSO specification no. RDSO/SPN/177/2012 Ver3.0 with latest amendment 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). The track-vacancy detection system at the Stations shall have only Main system with no Supervisory system.

(h) 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 meter 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.

(i) 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) Spare set of CPU card(s) fully programmed and configured shall be provided for each evaluator and kept ready for replacement. This shall be over and above the contract spares provide under Para 11.3.5.

(j) 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.

(k) 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.

6.1.6 Level Crossing Gate

(1) **System requirements**

(a) All the level crossing gates falling on DFCCIL shall be interlocked with signals as per execution sequence stated in Para 3.2

(b) There are level crossing gates in New ERC Mughalsarai- New Sonnagar & New Chiraillapathu section, which are being replaced by ROB/RUB in a phased manner. It is anticipated that ROB/RUB work on few LC gates is not likely to be completed before the commissioning of the section. Therefore, these LC gates will be required to be interlocked. List of level crossings is given at **Annexure 3**. Tentative Working of level crossing gates is given in **Annexure 4**.

(c) Huts at LC gates to be constructed by system contractor for interlocking and power supply equipments of LC gates.

(d) At present these 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) Separate power supply system for IR shall be installed at LC gate huts by system contractor for operation and interlocking purpose of LC gates.

(f) 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.

(g) 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.

(h) Colour light Road signals and audio warning shall be provided to warn the road users regarding the approach of a train.

(i) 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. Provision shall be made to display actual status (red/yellow signal) of road signal at the LC gate control panel or on a separate panel.

(j) 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.

(k) A common indication panel shall be provided in 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. Gate controlling circuit shall be changed to suit new conditions at LC gates for combining both IR and DFC gate signal. The contractor will be required to coordinate for approval of LC gate control circuit by IR and shall be required to extend concerned control of DFC relays to IR relay room and other locations of controlling LC gate. All necessary cabling to IR relay room and other locations and its termination shall be done by the contractor. Through these extended controls of DFC gears, IR shall modify their circuit and commission the LC gate. The contractor will be required to extend the IR gate signal aspects, approach track sections etc. to common indication panel through requisite interface as per approved LC Gate circuit by IR. At all stages necessary co-ordination shall be done by Contractor.

(l) The gateman shall be provided with facility to put back the gate signals to ON in case of emergency.

(m) 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.

(n) 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) as per provision of CRS Sanctioned SWR.

(o) 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/208/2012Ver 2.0 with latest amendment 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 as per para 6.1.9 (9).

(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 with latest amendment 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.

6.1.7 Points and Points machine

(1) System requirements

(a) Point machine shall be required to work with turnouts and derailing switches provided by the track contractor. The track contractor shall design the turnout and get it cleared from RDSO/Employer. Contractor shall co-ordinate with track contractor for design of point machine, ground connections and it's installation and testing. The parameters of turnouts and derailing switches are as under:

(i)	Gauge	1676mm
(ii)	Crossing angle	1 in12&1 in8½
(iii)	Rail Profile	60kg (UIC 60kg/m)
(iv)	Speed potential on main line	100km/h
(v)	Axle load	25tonne

(vi) Canted points with thick web switches and 1in20cantedturnouts weldable CMS crossings along with corresponding PSC turn out sleeper set

(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) Point machine shall be electric, shall conform to IRSS-24 or any other international standard and shall be already proven type in railway environment. The contractor shall get the point machine and ground connections approved from RDSO/Employer.

(d) Point shall be non trailable. Point machine shall be used in conjunction with external mechanical lock (clamp lock).Point machine shall operateon110V DC If the point machine is required to operate on any other voltage then suitable power supply arrangement shall be made for the same.

(e) All the points shall be worked with point machines.

(f) The contractor shall provide point machine and all mechanical rail connections except those fittings explicitly stated in the interface requirement to be under the responsibility of track contractor. Supplementary drives and detections shall be provided as required by the length of the point.

(g) All the points shall be worked with Electric Point machines.

(h) 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.

(i) 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.

(j) 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) 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 and clearance of signal. 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.

(b) Point detection shall be provided to detect that each switch is positioned correctly 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.

(c) 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.

(d) The relative position between the point machine and the stock rail shall be fixed such that independent movement is prevented.

(e) The super imposed detection is not permitted.

(f) 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.

(g) Provision shall be made for emergency operation of points during track section failure. Each such operation shall be recorded by a suitable counter.

(h) All point operating equipment and point operation & detection circuits shall be totally immune from traction current effects or other EMI sources.

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 prevent a minimum hazard to people walking along the track.

(b) As protection against dust, sand and splash water, the steel cover of the point machine must be provided with an appropriate seal. The cover shall be pad-locked.

(c) Each point machine shall be are number plate for identification.

(d) Track contractor shall lay the points and shall ensure that they meet the essential requirements before interlocking as specified in IRSEM. Contractor shall co-ordinate in this matter with Track contractor.

(e) Point machine shall be installed as per the requirements of IRSEM, clear of DFCCIL structure gauge. Contractor shall interface with track contractor for suitable design of PSC sleepers for mounting of point machine.

(f) Normally the machine shall be installed beside the close switch leading to high speed movement clear of all infringements.

(g) No point machines shall be installed in between the main line track.

(h) Maximum permissible length of operation of point machines shall generally be in line with 25kV AC traction requirement of IR and shall meet the EMI/EMC requirement of 25kVAC AT feed system of DFCCIL and 25kV AC traction on nearby IR.

(i) The point machine shall be installed as per RDSO/OEM checklist.

6.1.8 Relays

(1) The various types of relays used in interlocking systems shall comply with IRS specification no. S34 with latest amendment 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 minimized by design.

6.1.9 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 system contractor 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 system contractor will provide a LT panel in which he will make available the 230V power supply for the Signalling and Telecommunication system, if already not provisioned by contractor of CP-104.

(4) At other than OCC, the system contractor 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.

(5) he 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 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) The contractor shall carry out detailed power supply calculation for total load (including load of battery charging in boost mode) of every LC gate which is to be interlocked and depending on the load requirement at each LC Gate, an Integrated Power Supply (IPS)/Uninterrupted power Supply (UPS) system of appropriate capacity shall be provided at Gate lodge or at any location approved by engineer/IR.

(10) All design loadings and calculations are subject to acceptance and approval by the Engineer before installation commences.

(11) The IPS provided shall be as per specification RDSO/SPN/165/2012 with latest amendment and procured as per Para 4.2 of this specification. 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.

(12) The battery backup shall be provided with VRLA maintenance free cells as per specification IRS: S 93/96(A) with latest amendment 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.

(13) 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.

(14) Restoration of the primary supply shall cause a seamless changeover from the IPS/UPS back to the primary supply.

(15) 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.

(16) 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.

(17) An external bypass facility shall be incorporated in all IPS/UPS battery power supplies to cater for maintenance and failure requirements.

(18) Automatic monitoring of battery condition and charge state shall be provided as per para 6.5.

(19) 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.

(20) 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.

(21) Notwithstanding anything contained in this specification, the contractor shall be fully responsible for proper working of Signalling power supply system.

6.1.10 Power Supply System

6.1.10.1 Power supply scheme for S&T shall be based on 240v 50Hz AC LT supply.

6.1.10.2 240V 50Hz AC LT supply shall be provided by Contractor by tapping separate UP & DOWN 25kV AC AT feed system through AT of required capacity and local/DG/Inverter supply if any.

6.1.10.3 Contractor shall calculate the maximum electrical load (maximum combined load of all the signal & telecom equipments) of a particular AT installation.

6.1.10.4 Required AT Capacity (min10kVA) for each UP & DN AT shall be calculated such that the total load (maximum combined S&T load + Emergency load + any other load) on each.

6.1.10.5 ATs are not used more than 70% of its capacity.

6.1.10.6 Separate UP and DN AT of required capacity shall be provided for each station, level crossing gate, auto Signalling installation, telecom installation and any other S&T installation.

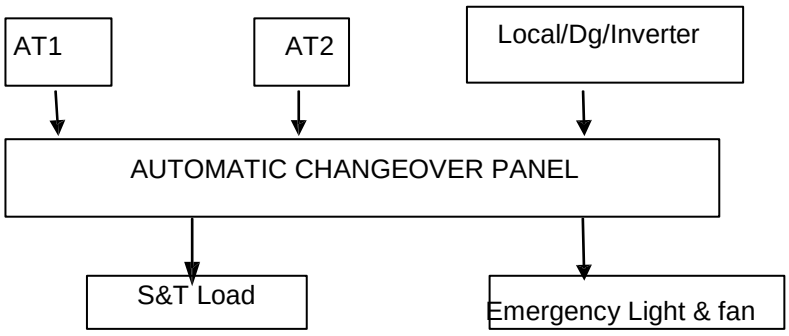
6.1.10.7 Each AT supply and local/DG/Inverter supply, as the case may be, will be terminated on an automatic change over switch/panel provided by the contractor. The auto change over shall also have the facility of the audio and visual alarm for the availability or otherwise of the power. The auto-changeover panel would conform to latest approved RDSO specifications.

6.1.10.8 Consecutive ATs shall normally be spaced at 4Kms, unless agreed to by the Engineer. 240V 50Hz AC power supply required for any S&T installation falling in between shall be taken on suitable LT cables (Minimum Two for each CLS Panel) to the destination and terminated on automatic changeover switch/panel by the contractor.

6.1.10.9 Electrical load to regulate temperature inside all SER/TER & normal Electrical load requirement (light/fan/power point etc.) of various operating/ S&T rooms/Gate Equipment lodges/Auto signal huts/telecom huts shall be separately calculated and catered for.

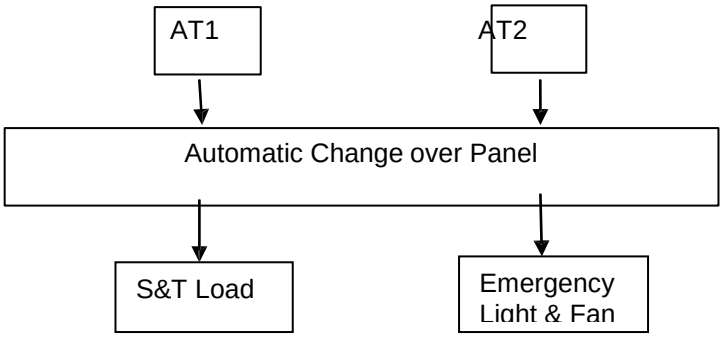
6.1.10.10 Notwithstanding anything written in this specification; contractor shall be fully responsible for providing a suitable robust, redundant and adequate power supply system for signal & telecom installation which shall meet the requirement of this contract.

6.2 Power supply Arrangement at a Station



Station Power supply arrangement

6.2.1 Two ATs of required capacity each connected to UP and DN catenaries shall be provided.
6.2.2 Local/DG/Inverter supply, if any, shall be the stand by source of supply.
6.2.3 Auto change over panel shall be provided in ASM/Panel room.
6.2.4 Power supply arrangement at a level crossing/Automatic Signal Interlocking/ telecom Installation**.**



LC Gate/Auto Signal/Telecom Hut Power Supply Arrangement

6.2.5 Two ATs of required capacity each connected to UP and DN catenaries shall be provided.

6.2.6 Automatic change over panel shall be provided in Power Supply/Equipment room.

6.3 Power supply system for Signalling equipment

6.3.1 Integrated Power Supply (IPS) working on input of 240V 50Hz input shall cater to the load of Signalling Equipment at stations/Auto Signal Interlocking/Gate Signal Interlocking. Separate IPS shall be provided for each location and at IR LC gate.

6.3.2 IPS shall be as per RDSO specification No. RDSO/SPN/165/2005 with latest amendment and shall be supplied from RDSO approved sources only.

6.3.3 For medium and big stations the IPS shall be as per RDSO letter No.STS/E/IPS/Genl. Dated 17.9.2008.

6.3.4 Contractor shall make a detailed Power Supply design and carry out a detailed power supply calculations for total Signalling load (including load of battery charging in boost mode) of every station/Auto Signal Interlocking/Gate Signal Interlocking. IPS configuration for a particular location shall only be finalized after this detailed design & calculation.

6.3.5 IPS shall provide separate DC/AC module(s) for every equipment/function such as EI, Relay internal, Relay external, Axle counter, AFTC, Block working, panel, signal lighting, track circuits, HRT/Magneto etc. All the modules including FRBC module, Inverter, DC- DC converter, AVR, Transformers shall be provided in n+1 hot standby configuration.

6.3.6 110V battery bank consisting of VRLA maintenance free cells as per IRS: S93/96(A) with latest amendment along with battery racks shall be supplied. Battery bank shall have adequate capacity to provide a backup time of minimum of 4 hours with maximum depth of discharge of the battery as 70%.

6.4 Installation

6.4.1 Earthling & Surge protection device to IPS shall be provided as per clause no.8.4 of this PS.

6.4.2 Suitable means to regulate temperature and maintain air circulation(with1+1 redundancy) at all stations buildings, auto location huts& LC gate Goomty within limits shall be provided so as to facilitate proper working of electronic equipment and VRLA battery as summer time temperature inside the equipment room is likely to reach very high levels. Status of temperature of station buildings, auto location huts& LC gate Goomty, functioning of the temperature regulator equipment and air circulation equipment shall be monitored and recorded through data logger.

6.4.3 The contractor shall be responsible for provision of all power supply requirements for the Signalling system downstream of the240V 50Hz AC feed in point.

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

a. Ensure that all items of electrical equipment are properly earthed and details shall be provided by the Contractor to demonstrate that protection is provided in the earthling concept.

b. Provided individual earth leakage detection for all AC and DC power supplies for the safety of the maintenance personnel and provide a visual indication to indicate if an earth leakage occurred. Where earth leakage detectors are not used, the design of the Signalling power supply distribution system shall ensure that earth leakages or inter core short circuits are detected and indicated through alarm.

c. Ensure that any failure of power supply equipment shall be recorded and indicated at the local control maintenance panel, local ASM, CMU panel.

d. Fuse Auto Changeover System (FACS) as per RDSO Spec. No. RDSO/SPN/209/2012 Ver 2.0 with latest amendment should be provided in indoor & outdoor Signalling circuit in addition to normal fuses as per approval of Engineers.

6.4.5 IPS shall provide all required voltages with appropriate power for all outdoor and indoor Signalling equipment of the location.

6.4.6 Relevant status indication of entire Power Supply System shall be transmitted to OCC/CMU/nearest DFC station.

6.4.7 Signalling power supply arrangement including IPS configuration and load calculation shall be approved by Engineer.

6.4.8 The equipment shall be installed by the OEM as per the pre-commissioning checklist issued by RDSO, if any.

6.4.9 Notwithstanding anything contained in this specification, contractor shall be fully responsible for proper working of Signalling power supply system.

(1) 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.

(2) 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.

(3) An external bypass facility shall be incorporated in all IPS/UPS battery power supplies to cater for maintenance and failure requirements.

(4) Any failure of power supply equipment shall be recorded and displayed on the Control terminal at the Station, S&D terminal at the Station and in the OCC.

6.5 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 Sonnagar and Chiraillapathu 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) Un-timely or out-of-sequence operation of equipment.

(v) Un-authorized 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).

(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.

*****End of Chapter*****

7. Train Management System

7.1 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 for entire section of New Mughalsarai to New Sonnagar & New Chiraillapathu. 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. The system contractor shall also collect all required Signalling information from various Stations/EI locations, Auto Location huts, LC Gates and other interlocking system for New Durgauti to New Karwandiya section.

3) Existing S&T system in New Durgauti- New Karwandiya section of DFCCIL is not having TMS and this section shall be included in TMS provision, and for that all the requisite hardware and software is in the scope of this system contract. Exchange of data from existing EIs of New Durgauti- New Karwandiya section shall be through appropriate communication interface from existing EIs by system contractor. Contractor shall interface with system contractor of New Durgauti-New Karwandiya section (66 Km) for implementation of TMS integration.

4) 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.

5) The system shall detect and manage alarms and logs generated in the system.

6) The system shall enable interconnection with other TMS systems of adjacent sections/backup OCC/ OCC which will be provided by other contractors of EDFC. The Integration of TMS at OCC with other TMS system shall be in the scope of this System Contract.

7) 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, provided in OCC 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.

8) The system shall be designed to be Modular, Robust, Scalable, Fault tolerant and based on Open architecture.

7.2 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 New ERC Mughalsarai- New Sonnagar and New Chiraillapathu section, including 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 7.10 (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 7.10(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 (APL-1). The related database shall be shared by this TMS with TMS of EDFC Phase 1 (APL-1). The contractors shall interface and jointly agree on the format and protocols for data exchange as per Para 7.10 (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 1 (APL-1) by having TMS provided under this contract sharing all relevant databases with TMS of EDFC Phase 1 (APL-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 Sonnagar and Chiraillapathu 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 and 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 (APL-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 7.10 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.

7.3 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.

(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.

7.4 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 (APL-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 7.2 (2).

(iii) All the Traffic related alarms described in section 7.2 (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 7.2 (5) and few of the Emergency Alarms are as follows:

1. Power supply failures at control centre, station, block section location or any node in network.
2. Central control internal communication failure.
3. Communication equipment failure.
4. Field control unit failure.
5. Failure of nodes.
6. System failure.
7. Interlocking interface failure (Way Side Communication Equipment).
8. 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 7.2 (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/IMSD

(i) The alarms for failure of vital Signalling and Power Supply Equipment in the jurisdiction of Station/IMD/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 adequate Nos. of Miscellaneous User TMS Terminals at important offices/locations as decided by Engineer. 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), for the terminals provided in the IR territory the network and requisite Power Supply shall be made available by the Employer.

7.5 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.

7.6 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 (APL-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	32”	1
Signal Fault Controller	32”	1
Track Controller	32”	1
Traction Power Controller	32”	1
Station Master at Station	32”	1
Crew Controller	32”	1
Signal Maintainer at Station, IMD and IMSD	32”	1
Miscellaneous User TMS Terminals	32”	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.

7.7 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 Aluminum 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 Mughalsarai-New Sonnagar and Chiraillapathu section including New Durgauti- New Karwandiya of existing DFC section.

(x) The Video wall system shall be generally similar in appearance to the other Video wall system planned/provided in EDFC Phase 1 (APL-1), so as to have uniformity with existing system. The Contractor shall interface with the contractor of EDFC Phase 1 (APL-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)

Item	Specification
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 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

Item	Specification
Startup	Instant hot restart
Component life- DMD Panel	Shall be greater than 650,000 hours

(3) 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.

(4) 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.

7.8 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.

7.9 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.

7.10 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 (APL-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 (APL-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 (APL-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*****

CHAPTER 8: CONSTRUCTION REQUIREMENTS

8.1 General

8.1.1 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.

8.1.2 The requirement of Construction/Installation Plan, Method Statement, Manufacturing/Procurement, Delivery, Storage and Installation at site are covered in detail in General specifications. The requirement given here are specific requirements to be read in conjunction with the general requirements given in the GS.

8.1.3 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.

8.2 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.

8.2.1 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.

(h) Cable runway plan for taking cable from one equipment to another.

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

8.2.2 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 New Sonnagar Station are being built by CST contractor of this section as part of Station building. The Contractor shall coordinate with CST contractor for construction of the same. The air-conditioning of SER at Stations is being provided by system contractor. 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 at other stations at New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Chiraillapathu are in the scope of present contract under station building. Also the buildings and structures in the block section and at LC gates are within the scope of present contract. 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.

8.2.3 Smoke and Fire detection system will be provided in all Signalling Equipment rooms, telecom equipment rooms, Signalling Power supply equipment rooms with facility of alarm generation at stations and other S&T equipment installation sites by the contractor.

8.2.4 Outdoor Installation

(1) All the ducts/ troughs/pipes/HDD for laying cables will be provided by system contractor except at locations where CST contractor has already laid provision for laying/track crossing of cables.

(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.

(6) All warning boards, Markers, Signal name plates, concern Signal, instruction boards etc. shall be provided with retro reflective or better type duly approved by Engineer.

8.3 Signalling Cable Laying, Termination and Testing

8.3.1 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 with latest amendment. 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 aluminum conductor ,minimum conductor size 25 sq. mm, PVC – insulated armoured, unscreened, underground power cable as per specification IRS: S-63/2007 with latest amendment & 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. The Signalling system shall interface with the Telecommunication system for the same.

(5) Indoor cable/wire used shall be 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 with latest amendment.

8.3.2 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 with ring arrangement.

(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. The quad cable used for signalling functions and emergency communication shall also have 20% (of the total conductors used) spare conductors.

8.3.3 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.

8.3.4 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.

8.3.5 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 (10m-12 m)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.

8.3.6 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 meters.

(6) The depth of cable trench shall be minimum 1.2 meters to comply Para 8.3.7 (8) of this specification.

(7) It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.

(8) 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.

(9) 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.

(10) 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.

(11) Backfilling of the trenches shall be done properly. The earth excavated shall be put back on the trench rammed and consolidated.

8.3.7 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. Joint Procedure order is at Annexure-1.

(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 meter 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 meter (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 meters.

(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 meter thickness and thereafter a protective cover of trough or a layer of approved split DWC pipe shall be placed.

(10) 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 meters, 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.

(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-2 (a) and Annexure-2 (b) respectively.

(12) At each end of the main cable an extra loop length of 6 to 8 meter 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.

8.3.8 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 meters, a minimum distance of 3 meters between the cable and the nearest edge of the O.H.E. structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in concrete/heavy duty HDPE/Ducts or any other approved means for a distance of 3 meters on either side of the Mast. When so laid, the distance between the cable and 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 meter 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 meter away from the substation earthing. In addition, the cable shall be laid in concrete or heavy duty HDPE pipes/or other approved means for a length of 300 meters on either side of the feeding point. As far as possible, the cable shall be laid on the side of the track opposite to the feeding post.

(3) In the vicinity of the switching stations, the cable shall be laid at least one meter away from any metallic body of the station, which is fixed in the ground, and at least 5 meters away from the station earthing. The distance of 5 meters can be

reduced to one meter 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 meter 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 meters away from the centre of the Track.

8.3.9 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.

8.3.10 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.

8.3.11 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 meters 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) Approved split DWC pipe 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.

8.3.12 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.

8.3.13 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 meters beyond the building line. In such cases, the cable shall be protected by means of concreting of 50 mm as proposed for rocky soil with approved split DWC pipe.

8.3.14 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 meter (minimum) below the ground level/bottom of the sleeper.

(e) No digging shall be done below the sleepers.

8.3.15 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 meter from the ground level. It shall extend 1 meter (minimum) on each side of the road keeping in view the future increase of width of the road.

(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.

8.3.16 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. Wherever cable may not be taken underground across the drain bed, cable shall be taken on the culvert through GI trunking/GI/DWC-HDPE pipe of suitable sizes.

(2) When cables have to cross a metallic bridge, they shall be placed inside a metallic trough which may be filled by an anti-theft measure (sand and charcoal), 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.

(3) In case of arch bridges, cable shall be taken through GI trunking/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 meter (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.

8.3.17 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.

8.3.18 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

8.3.19 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. Electronic cable marker should be robust, passive, non-rusting & water proof. It shall be possible to trace their location with the help of cable marker tracing unit up to a depth of 1.5 meters.

8.3.20 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 DieneTerpolymer). 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 meter 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 meter 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) Cable should be entered in location box and their coils buried at a minimum depth of 0.5meter.

8.3.21 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.

8.3.22 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 7.4.5(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. Separate power cable shall be used to provide the lighting arrangement.

(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.

8.3.23 Entry of Cable in Point JB:

Point JB shall be fitted with suitable no.s of ARA PB terminal Block conforming to IRS – S-75/91 with latest amendment as per drawing no. SGW/MGS/PT4/91.In Point JB cables should be entered through GI Pipe of suitable diameter, edge of should be bend to avoid damage of cable with sharp edge of pipe and concrete foundation duly approved by Engineer shall be done.

8.3.24 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.

8.3.25 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.

8.3.26 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.

8.4 Earthing and Bonding

8.4.1 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.

8.4.2 Indoor Signalling installation

(1) The Equipment rooms housing Indoor Signalling equipment and their Power supply shall be provided with suitable Earthing and Bonding system.

(2) There shall be one equipotential earth bus bar for each of the equipment rooms viz. Signalling equipment room, Power supply equipment room etc. The equipotential earth bus bars located in individual rooms shall be termed as Sub equipotential earth bus bars (SEEB). The equipotential 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 equipotential earth bus bar (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 bus bar (SEEB) installed in the rooms shall be directly connected to Main equipotential earth bus bar (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 meter 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.

(11) **Fire alarm system for Signal & Telecom Indoor Installation**: Fire alarm system shall be provided as per RDSO Specification no. RDSO/SPN/217/2016 (Draft) with latest amendment at all rooms viz. Relay room, IPS room, Signal Batter Room, Telecom Equipment Room, Telecom Power Supply room & ASM Room as per approval of Engineer.

8.4.3 Outdoor Signalling installation

(1) All the Outdoor Signalling equipment viz. Signals, Location boxes, Lifting barriers, point machines, track devices etc. shall be provided with suitable Earthing arrangement.

(2) All concrete foundations viz. Location boxes, signals, DPs, Point JB and others shall be painted with double coat white enamel paint duly approved by Engineer.

(3) 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.

(4) 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.

(5) 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.

(6) Where the equipment to be earthed are in close vicinity they should be connected to a common earth in star configuration.

(7) For outdoor Signalling items installed in Location boxes, one earth bus bar 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 bus bar.

(8) GI wire as earthing bond shall not be used.

8.4.4 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.

8.4.5 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%
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	Encapsula

SN	Parameters	Limits	
		Between Line & Neutral	**Between Neutral & Earth**
			ted
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^{o}C to + 80^{o}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

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*****

9. TESTING AND COMMISSIONING

9.1 General

9.1.1 The general details of Testing and Commissioning Philosophy, Strategy, Program, Plan and procedures is covered in Part 2 " Employers Requirement, Section V(A), Volume 5.The specific requirements of Testing and Commissioning covered here shall be read in conjunction with the general requirements covered in GS.

9.1.2 All costs associated with the testing shall be borne by system Contractor. This shall include the Inspection/Testing Charges to be paid to RDSO/RITES/Test Laboratories. The system 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.

9.1.3 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.

9.2 Type Tests

9.2.1 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

9.2.2 Type tests on equipment for which RDSO specification exists, if required shall be done as per applicable RDSO specification.

9.3 Factory Acceptance Tests

9.3.1 The FAT is carried out to demonstrate that each equipment/sub-system meets its functional specifications.

9.3.2 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.

9.3.3 FAT procedure shall be submitted for review by the Engineer Twenty Eight (28) days in advance of carrying out any Test.

9.3.4 The FAT shall be witnessed by Engineer/Employer's representative.

9.3.5 Where processor based equipment is to be used, the FAT shall also include verification of application software.

9.3.6 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.

9.3.7 The EI application logic/software for every station and auto section shall 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.

9.4 Installation Tests

9.4.1 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.

9.4.2 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.

9.5 System Acceptance Test

9.5.1 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.

9.5.2 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

9.5.3 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.

9.5.4 Prerequisites for commencement of the System Acceptance Tests (SAT):

9.5.5 All documentation for the System Safety report have been submitted to the Engineer for review;

9.5.6 All Installation Tests have been completed and test records submitted to the Engineer for review;

9.5.7 Facilities for the maintenance of the system are in place; and

9.5.8 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.

9.5.9 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) El 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 (for both small train and full length train);

(h) Block controls;

(i) Level crossing controls;

(j) Emergency cancellations;

(k) Emergency operation of points;

(l) Track locking test;

(m) Square sheet test;

(n) Crank handle interlocking;

(o) Aspect sequence and cascading arrangement (horizontal and vertical).

(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.

9.6 Integrated Testing and Commissioning

9.6.1 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.

9.6.2 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.

9.6.3 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.

9.6.4 Integrated testing and commissioning shall include the integration of the section (Mughalsarai-New Sonnagar and Chiraillapathu) with the adjacent already commissioned sections including OCC, without disturbing the safety and revenue operation of the earlier sections.

9.6.5 Conducting of these Integrated Tests by the Contractor and the other contractors shall include a period of Trial Run.

9.6.6 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.

9.6.7 The results of the Integrated Testing and Commissioning shall be documented.

9.6.8 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.

9.7 Trial Runs

9.7.1 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.

9.7.2 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.

9.7.3 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.

9.7.4 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.

9.7.5 The Contractor's personnel shall be available throughout the period of Trial run.

9.7.6 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.

9.8 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*****

CHAPTER 10: DOCUMENTATION

10.1 General

Requirements of Documentation in general are covered in Part 2, “Employer’s Requirement”, Section V(A), Volume 5. This chapter mentions particular requirements of Documentation for Signalling System.

10.2 List Of Documents

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

10.2.1 Management Plans

a) Project plan
b) Interface management plan
c) Quality plan
d) Safety plan,
e) EMC management plan
f) Construction & installation management plan
g) Design plan(Including design verification & validation& design quality plan)
h) Type testing & factory acceptance testing (FAT)plan
i) Procurement, manufacture & delivery plan
j) Testing& commissioning plan,
k) Operation & maintenance plan
l) Training plan
m) Spare parts & consumable management plan
n) Defect liability management plan
o) Maintenance management plan
p) Trial run plan

10.2.2 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

10.2.3 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.

10.2.4 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

10.2.5 Operation and Maintenance Manuals

Requirements of Operation and Maintenance Manuals in general are covered in Part 2, “Employer’s Requirement”, Section V (A), Volume 5.

10.2.6 Documents for CRS Sanction

Preparation of CRS application along with supporting documents, including Station Working Rules (SWR), Gate Working Rule (GWR), SIPs, SWRDs , ESP, control table, approved special instructions/special instructions if any deviation from G&SR, and any other relevant document required for CRS sanction.

*****End of Chapter*****

CHAPTER 11: SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

11.1 General

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.

11.2 Supply of Spares

11.2.1 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).

11.3 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).

11.3.1 Defects Liability Spares

(1) The system 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 system 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 system Contractor shall ensure availability of 'Defects Liability Spares' on or before the commencement of the DNP.

11.3.2 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.

11.3.3 The system 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.

11.3.4 The system 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.

11.3.5 Contract Spares

(1) The system 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 posts, CLS units etc. Signal Lighting Units etc.	Nos.	5% of each type installed. Subject to 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 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	Nos.	15% of each type installed subject to minimum of one.

SN	Item	Unit	Quantity
	networking equipment (except Server) with interconnecting cables and connectors and all other associated accessories.		
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/ materials which are not included above	Nos.	15% of each type installed subject to minimum 2 Nos.

(3) The system 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 higher 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 and 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 system Contractor shall complete supply of the 'Contract Spares' on or before start of Defects Notification Period.

(8) The system 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.

11.3.6 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;	Nos.	10

SN	Item	Unit	Quantity
	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. (all measuring tools calibration certificate with validity shall be submitted along with measuring tools)		
2	Megger100/500V AC 0 to 200 M ohms with earth tester, electronic push button type of Philips or any other reputed make	Nos.	10
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.	10
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.	5
5	Supply of electric drill machine of size 6 mm and other description as per 4 above.	Nos.	5
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.	10
7	Laptop based mobile maintenance terminal (uploaded with general and special software required for maintenance and diagnostic for EI, MSDAC, SSDAC, BPAC, UFSBI etc. as decided by Engineer).	Nos.	15
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	3 sets
12	Computer based test set up with required software for automatic testing like 'Functional Testing', Simulation testing as per control table, Square sheet test etc.	Nos.	1 no. for each EI.
13	DC Clamp meter (Fluke Make model No. 325 or Similar as approved by Engineer)	Nos.	2 no. for each EI.
14	Rail hole drilling Machine (BDS make model RailMAB 925 or Similar) for Axle Counter with accessories with Portable Generator set of suitable capacity for Operating RailMAB 925 & MAB 825 Drill Machine as advised by Axle Counter	Nos.	1 no. for each EI.

SN	Item	Unit	Quantity
	OEM and approved by Engineer.		
15	Switch Rail hole drilling Machine (BDS Make Model MAB 825 or Similar) for Point Machine with accessories as advised by Point Machine OEM and approved by Engineer.	Nos.	1 no. for each EI.

(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 system 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 system 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, identified, 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 system 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.

11.3.7 The system 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, and IPS/UPS etc. The testing platform shall be commissioned before revenue operations.

11.3.8 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*****

12. INTERFACE REQUIREMENTS

12.1 General

12.1.1 The system 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.

12.1.2 Co-ordination responsibilities of system 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.

12.1.3 Receipt from interfacing parties of such information as is reasonably required to enable Contractor to meet design submission schedule as identified in Part 2, Volume 1 General Specification.

12.1.4 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.

12.1.5 The system 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).

12.1.6 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.

12.1.7 The system 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.

12.1.8 The system 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.

12.2 Interface Management Plan (IMP)

12.2.1 The system 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.

12.2.2 The system 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.

12.2.3 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.

12.2.4 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).

12.2.5 The timescale for resolving interfaces shall be set down in Co-ordinated Interface Document (CIP) and with the each Other Interfacing Contractor(s).

12.2.6 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.

(5) System contractor shall design the Signalling and telecommunication system of this section which should be compatible with the existing S&T system installed and commissioned in New Durgauti- New Karwandiya section of DFCCIL.

12.2.7 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.

12.2.8 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.

12.3 Interface Management

12.3.1 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.

12.3.2 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.

12.3.3 The Contractor shall co-ordinate all interface items on the list and agreed solutions with the other contractors.

12.4 Dedicated Co-ordination Team

12.4.1 The Contractor shall establish a dedicated co-ordination team led by a coordinator reporting to the Contractor's Project Director.

12.4.2 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.

12.4.3 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.

12.4.4 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.

12.4.5 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.

12.4.6 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.

12.4.7 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.

12.5 Coordination with other Contractors and Indian Railways

12.5.1 The Contractor shall undertake design co-ordination with other contractor(s) and Indian Railways.

12.5.2 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.

12.5.3 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.

12.5.4 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.

12.5.5 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.

12.5.6 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.

12.5.7 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.

12.5.8 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.

12.5.9 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.

12.5.10 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.

12.6 Signalling and Telecom Systems Interface Requirements

12.6.1 The Contractor shall coordinate with other contractors working in the section viz. CST Contractor(s) for Buildings & Structures and Track engaged by Employer for New ERC Mughalsarai-New Sonnagar and New Chiraillapathu section, CST and system contractor of New Durgauti- New Karwandiya section. The Contractor shall also coordinate with Indian Railways officials, government departments etc., as required, for timely completion of the Work.

12.6.2 The Contractor shall prepare 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.

12.6.3 The Contractor shall ensure that the issues/information pertaining to them that have been included in the IMP and ICD are timely exchanged/resolved and have no bearing on the Works Programme.

12.6.4 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.

12.6.5 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) Right of Way and Access free of encumbrances to sites on Main Line and at Stations.

(2) Regarding track alignment, cant, versine, track geometry, rail levels, gradient curve details, track center along with transition curve details.

(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	System 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) New Sonnagar Junction Station.	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 requirements 1, 2& 3 given by system contractor in the concerned rooms.	Approved drawing, sketch etc. of item 1,2 & 3 shall be provided by System contractor to CST Contractor.
2	Station Building at New ERC-Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Chiraillapathu 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 along with E&M works.	1. Shall incorporate this requirement in relevant drawings.	Approved Site Plans for the SER/TER/Power Supply Rooms.
3	Design and Construction of 2 relay huts at New Sonnagar Junction station area.	1. Shall decide the location for construction of any additional Signalling structures in Station area in coordination with the CST contractor.	1. Shall incorporate this requirement in relevant drawings. 2. Shall construct these additional Signalling structures in Station area.	Approved Site Plans for the SER/Power Supply Rooms.
4	Signalling Equipment Room (SER), Telecom Equipment Room (TER) and S&T Power Supply Equipment Room(s) in Block Sections (For Auto Signal Location/Telehuts/LC Gate Goomty),	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 along with E&M works.	2. Shall incorporate this requirement in relevant drawings.	Approved Site Plans for the SER/TER/Power Supply Rooms.
5	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

6	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.
7	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.
8	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
9	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	
10	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.	
11	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.	
12	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.	Jointly signed drawing showing the centre-lines of rail tracks and the road w.r.t to a permanent land mark.

12.6.6 System Contractor shall be responsible to integrate the TMS and extension of control circuits of New ERC Mughalsarai-New Sonnagar & New Chiraillapathu including New Durgauti-New Karwandiya section to OCC at Allahabad.

12.6.7 The inputs required for interfacing the New Durgauti-New Karwandiya Section for TMS and extension of control circuits shall be provided by this system contractor.

12.6.8 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.

12.6.9 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 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*****

13 TRAINING

13.1 Scope of Training

13.1.1 The objectives of this training are as under:

a) to enable the Employer's operation &maintenance personnel to operate, maintain & carry out alterations, if need be, in the commissioned signalling system and

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

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

a) Operating features and functional principles of the relevant Systems;
b) System engineering aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations ,insulation and protection co-ordination;
c) Details of major equipment and components used in the System;
d) System installation, operating and maintenance management procedures.
e) Control and monitoring systems for each System.

13.2 General Requirements

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

13.2.2 The system Contractor shall provide comprehensive training to the Employer's maintenance, Operating personnel and Key Instructors.

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

13.2.4 The training instructors shall be qualified and competent with sufficient years of practical experience in the relevant fields and possess good communication skills. The training instructors shall be competent staff of the Contractor, the sub-contractors or the equipment manufacturers.

13.2.5 Training shall be conducted in English Language. The respective training manuals will be provided in English. If asked by Engineer, the training manuals will be provided in Hindi also.

13.2.6 The training shall be carried out at site or in DFCCIL Corporate/Regional office .The cost of travel and boarding/lodging of Employer's personnel shall be borne by DFCCIL.

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

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

13.2.9 The Contractor shall be required to arrange training to the Employer's staff in respect of design, installation, testing and commissioning of the System and each sub system.

13.3 Training Plan

13.3.1 The Training Plan shall be prepared by the Contractor and submitted to the Engineer for review..

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

A the program of the training courses and submission schedule of the training materials;
B over view and description of objectives of each training course.
C the location where the training courses to be conducted;
D set ups for practical exercises.
E the Contractor's training organization, chart, including the role and responsibilities of individual key persons;
F the qualifications and experience of the training instructors;
G details of training simulators to be provided or developed, if applicable.

13.4 Training Courses

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 class room, 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 phase with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation and commissioning of the equipment which is the subject of the training. The Contractor shall ensure that the courses fully encompass all aspects of the basic design, manufacture, installation, commissioning and maintenance of the Equipment with maximum effort being directed at instruction in the maintenance of the installations.

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

a) EI;
b) IPS
c) Track Vacancy Detection Systems
d) TMS/CMS.
e) Data Logger
f) Point Machines
g) ELD

13.4.4 The Employer's Key Instructors shall attend all types of training courses so that they shall be able to subsequently train the Employer's staff in future in all aspects of operation and maintenance of the System.

13.5 Operating Staff Courses

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

A Overview of the relevant System.
B Description of the operation principle of all Systems and Subsystems
C Description for operating technical equipment
D Operational features and functions

E Familiarization and use of all man-machine interfaces involved
F Reading and interpretation of system status and alarm messages or indications
G Normal and degraded operating procedures
H Operating procedures under emergency situations;
I Procedures for recovery from minor or simple faults;
J Use of operating and Maintenance Manuals and documentation;
K Detailed knowledge and correct application of operating rules and procedures and
L Local knowledge of stations and the line.

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

13.6 Maintenance Staff Courses

13.6.1 The maintenance staff courses shall be developed to provide all necessary knowledge and skills:

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

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

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

13.6.3 Level &Types of Maintenance

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

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

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

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

13.6.4 Training shall be based upon a ‘two -stage’ concept as follows:

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

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

13.6.5 The Contractor shall determine the contents of the courses and the courses shall include the following as minimum

A Overview of the relevant System
B System features and functions
C Operating principles
D Description of system components
E Test and commissioning procedures
F Use of test equipment and special tools
G Reading and interpretation of alarms, indications, messages and print-outs
H Preventive maintenance procedures
I Fault diagnosis, trouble shooting and corrective maintenance procedures
J Equipment settings and parameters configuration
K Use of equipment manuals, operating and maintenance manuals, circuit diagrams and wiring schematics
L Methods and procedures to provide new circuits, system expansion and enhancement
M Data, software backup and loading
N Use of software such as peripheral control and configuration, utility, database structure, generation and modification.

13.6.6 Practical exercises shall be provided for each trainee to practice the following as minimum:

A Use of test equipment and special tools;
B Preventive maintenance;
C Fault diagnosis and troubleshooting with induced faults set by the instructor to simulate real-life situation and
D Faulty modules or cards replacement and restoring the system to normal operation.

13.7 Training Materials

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

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

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

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

13.7.5 Training Manuals shall become the property of the Employer.

13.7.6 The Employer reserves the right to copy all Training Materials for use in Training Courses.

13.7.7 All the training materials shall be accurate and match with the actual design of the System.

13.8 Training Period

13.8.1 100 trainer man days training shall be provided in India. Class size shall be a maximum of 30 trainees.

13.9 Training Records

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

13.9.2 The Contractor shall issue appropriate training certificate to the trainees who pass the assessment.

13.10 Course Evaluation

13.10.1 The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Engineer for review four weeks before the commencement of the training course.

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

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

13.10.4 The contractor shall submit the course evaluation criteria one month before start of the training to the Engineer for approval.

End of chapter

14. Building and Civil Structure

14.1 Objective

14.1.1 The work involved in this bid is Design, Construction, Testing and Commissioning of the Service buildings and structures for Station Building, 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 by the Contractor in the manner and time stipulated in the Contract and to achieve the standard, performance & functionality specified in the Contract.

14.2 Scope of Works

14.2.1 The scope of works includes but not limited to :-

a) Design and construction of all civil works for the building at New ERC-Mughalsarai, New Ganjkhwaja, New Sonnagar Link & New Chiraillapathu including E&M works and other S&T related works. The total size of building of 4 above stations are total 882 Square Meter approx. A sample building plan of New ERC-Mughalsarai, New Ganjkhwaja, New Sonnagar Link & New Chiraillapathu is given at **Annexure-5**.

b) Design and construction of all civil works for the buildings and structures including E&M works and other S&T related works for auto location huts/Telehuts of Size 66.5 Square Meter (approx.) each, approximately 30 in nos., however the exact number of such civil structures shall be decided based on the designs approved by the Engineer. A sample building plan of auto location hut is given at **Annexure-6**.

c) Design and construction of all civil works for the buildings and structures including E&M works and other S&T related works for LC Gate Goomty of Size 36 Square Meter (approx) each, approximately 18 in nos. (as per list given in Annexure 3), however the exact number of such civil structures shall be decided based on the designs approved by the Engineer. A sample building plan of LC Gate Goomty is given at **Annexure-6.**

d) The E&M works includes standard electrical wiring, fittings (like ceiling/exhaust/cabin fans, indoor and outdoor lighting, power sockets etc.) and optimum air conditioning shall be provided in S&T equipment room, ASM room, Telecom equipment room and at other locations as approved by Engineer.

e) For detailed specification of all electrical items and fittings, the specification given in PS-Electrical works shall be followed by the system contractor.

f) All buildings, required to be constructed under this Contract, shall comply with the applicable Indian building standards and codes. Wherever Standard Railway drawings for buildings are available these shall be followed.

g) Contractor to submit all building plans for prior arrangement of Engineer.

h) Buildings at locations mentioned in para 14.2.1 (a) above, should have proper water supply arrangement, sanitary arrangement, septic tank and drainage. One borewell with the provision of submersible pump, rising, delivery pipeline connection to tank over buildings, distribution pipe lines etc. and one borewell equipped with hand pump should be provided to meet water requirements of staff in all seasons at these locations.

i) Provision of internal wiring, points & switches shall be made for illumination of buildings as approved by the Engineer.

j) Energy efficient copper wires for internal wiring, points, switches, holders, MCB, main switch boards etc. shall be provided as approved by the Engineer.

k) The foundations of Station Building shall be designed for at least one storey more than the requirement.

l) The plinth level of Station Building and other structures connected with direct operation of trains shall be minimum 300mm above the Rail level or 600mm above ground level whichever is higher.

m) Load due to earth quake (as applicable for the earth quake zone in which the building falls) shall be assessed as per provisions of relevant IS Code with latest amendments/revisions.

n) Load and load combinations shall comply with relevant Indian Standard with latest amendments.

o) All buildings shall be amenable to maintenance with minimum efforts.

p) All buildings shall be provided/with concealed ducts/pipes for power supply and telecom facilities in addition to ducts/pipes for power supply and distribution. These arrangements shall be made in consultation with Engineer. The provision of emergency supply circuit shall also be given.

q) Station and other Building signages shall be designed and provided.

14.2.2 **CONSTRUCTION**

1) The design shall be capable of allowing the construction to be carried out in the minimum time possible and to the required quality standards.

14.2.3 **DURABILITY**

1) The buildings shall be durable and serve satisfactorily for full service and designed life.

2) The building shall be designed to withstand relevant weather conditions of exposure as per the Indian building codes.

3) Buildings shall be specially detailed for ductility requirements as per the relevant codal provisions.

14.2.4 **MAINTAINABILITY**

1) All buildings shall be capable of maintenance with minimum effort.

14.2.5 **AESTHETICS AND CONFORMITY**

1) The architecture and profile of all buildings shall conform to the local aesthetics, cultural ethos, local architecture and environment, wherever applicable.

14.2.6 **RESPONSIBILITY**

1) The Contractor is fully responsible for obtaining the necessary clearances for all the drawings including General Arrangement Drawings (GADs) from the pertinent Central/State/local authorities before the commencement of construction. Employer shall assist the Contractor in this regard.

14.2.7 **Site Publicity**

1) The Contractor shall ensure that safety, rescue and industrial health matters are given a high degree of publicity to all persons regularly or occasionally on the site.

14.2.8 **Fire Regulations and Safety**

1) The Contractor shall provide and maintain all necessary temporary fire protection and fire fighting facilities on the site during the construction of the Works, and shall comply with all requirements of the local fire services department.

2) These facilities may include, without limitation, sprinkler systems and fire hose reels in temporary site buildings, raw water storage tanks and portable fire extinguishers suitable for the conditions on the site and potential hazards.

3) The Contractor shall submit details of these facilities to the Engineer for review prior to commencement of work on the site.

14.2. 9 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.

14.2.10 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.

14.2.11 Obtaining all necessary approvals from the relevant authorities for design and construction of the Works.

14.2.12 Rectification of the defects in the Permanent Works in a manner and to the standard as stipulated in the Employers Requirements.

14.2.13 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.

14.3 Architecture

14.3.1 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.

14.4 General Design & Construction Criteria

14.4.1 All buildings, required to be constructed under this Contract, shall comply with the applicable Indian building standards and codes. Wherever Standard Railway drawings for buildings are available these shall be followed.

14.4.2 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.

14.4.3 Contractor to submit all building plans for prior agreement of Engineer.

14.4.4 Ceiling fans shall be provided for air circulation is required which will be indicated by Engineer.

14.4.5 Exhaust fans shall be provided in toilets and other locations as directed by the Engineer.

14.4.6 Illumination of buildings and installations shall be as approved by Engineer. This should cover illumination of outside area of the building also.

14.4.7 Energy efficient LED fittings shall be provided.

14.4.8 Necessary provision for Air-Conditioning, as required, shall be provided in SERs and TERs.

14.4.9 Environmental friendly material and equipment shall be used to the greatest extent possible.

14.5 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 minimize 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.

4. The buildings shall be durable and serve satisfactorily for full service and designed life.

5. The building shall be designed to withstand relevant weather conditions of exposure as per the Indian building codes.

6. Buildings shall be specially detailed for ductility requirements as per the relevant codal provisions.

7. All buildings shall be capable of maintenance with minimum effort.

14.6 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. The exact size of the SERs, TERs and S&T Power Supply Equipment Rooms will be determined at the design stage as approved by Engineer.

3. The architecture/finishing of station building should be in line with the design of station building in New Durgauti-New Karwandiya section of DFCCIL.

4. The plinth level of Signalling Equipment Rooms, Telecommunication Equipment Rooms and Signalling& Telecommunication Power Supply Equipment Rooms and station buildings shall be at least 300mm above the Rail Level. The ceiling height of these rooms shall be approximately 3 (three) m above floor level.

5. 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.

6. Chain Link Fencing shall be provided around SER, TER and S&T Power Supply Equipment Rooms constructed under this Contract. The distance of chain linking fencing from the walls of SER, TER and S&T power supply equipment rooms shall be generally 1.5 meters or as decided and approved by the Engineer.

7. The locations of Permanent Structures shall be decided taking due note of the possible operational requirements in coming years.

8. The foundations of buildings shall be designed for at least one story more than the requirement.

9. 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.

10. 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.

11. 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.

14.7 The Specifications for Station Building, SERs, TERs and S&T Power Supply Equipment Rooms are given in Table 1:

Table 1: Technical Specifications

Sr. No	Description	Specification	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 design approved by Engineer.	
		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	
6	False Ceilings	600 x 600mm calcium silicate panels for Signal and Telecom Equipment Room.	

14.8 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:-
   i) The Works have been or shall be designed, manufactured, installed and otherwise constructed to the applicable standards available using proven upto date good practice.

   ii) The Works shall, when completed, comply with enactments and regulations relevant to the Works.

   iii) 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.

   iv) The Building Works shall comply with Indian standards and IR regulations and standards as set out in this document.

14.9 Aesthetics

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

14.10 Quality Control

14.10.1 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

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.

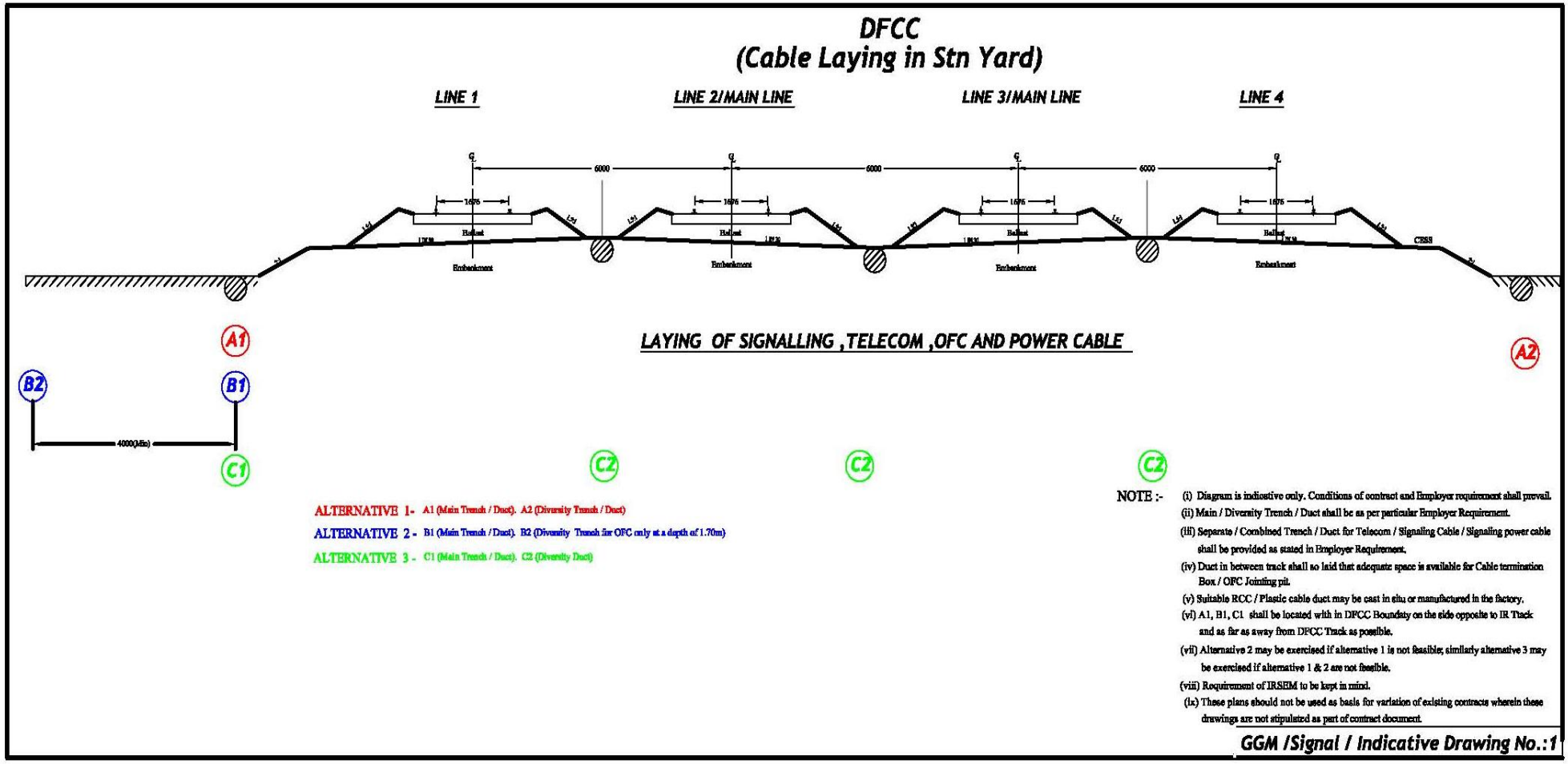
(17) The S&T cable and Electrical cable route plan should be got approved from the concerned Sr. DSTE/DSTE & Sr. DEE/DEE respectively, before undertaking the work and completion cable route plan should be finalized Block section by Block section as soon as the work completed.

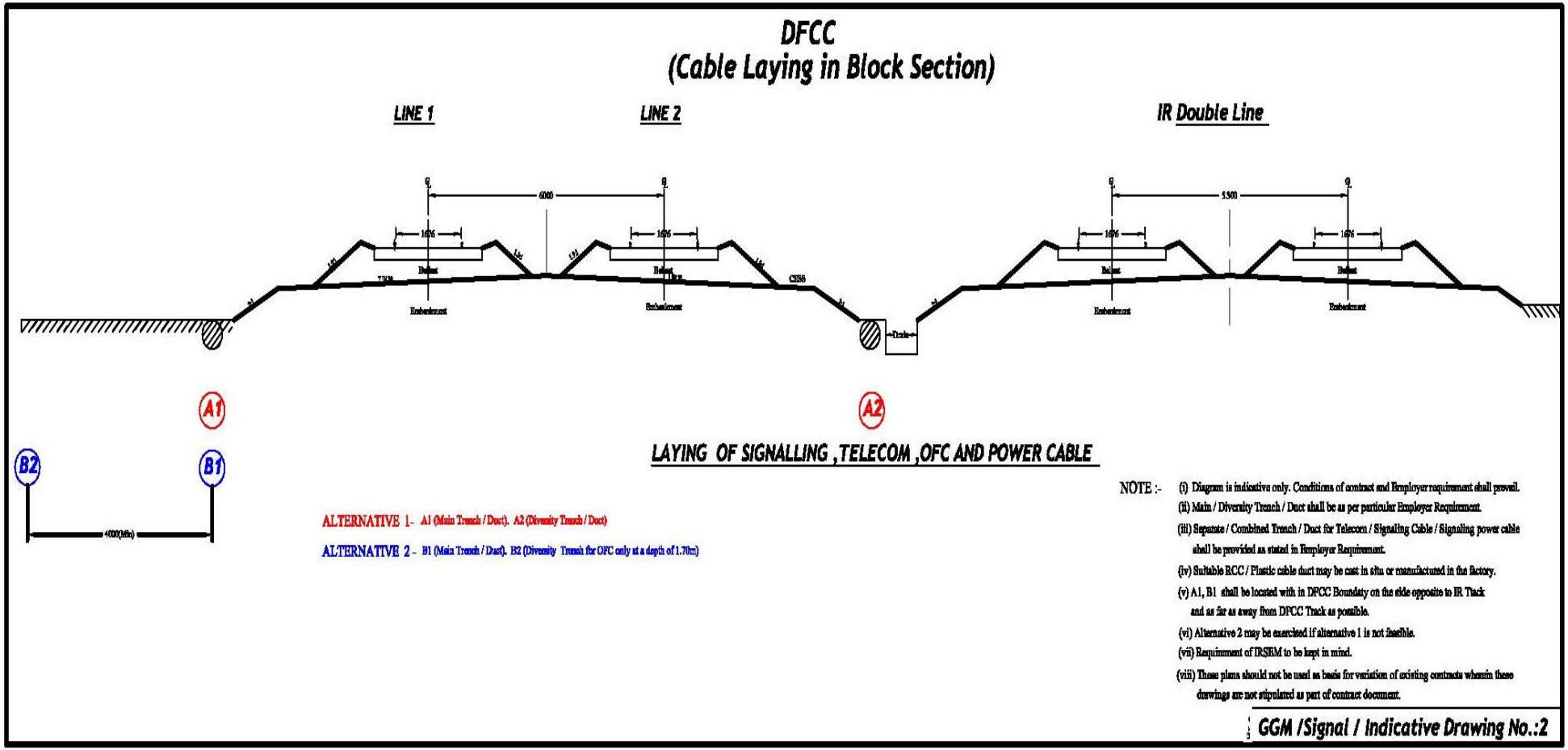
NOTE: Various designations mentioned in the above Joint Procedure Order are for Railways. In the DFCCIL work, all approvals/inspections will be by the Engineer rather than the designated officials mentioned in the above Joint Procedure Order.

End of Annexure 1

Typical Arrangement for Cable Laying in Yards

Annexure-2(a)




DFCC
(Cable Laying in Block Section)
LINE 1
LINE 2
IR Double Line
6000
5500
1676
Ballast
Embankment
A1
A2
B2
B1
4000(Min)
LAYING OF SIGNALLING ,TELECOM ,OFC AND POWER CABLE
ALTERNATIVE 1- A1 (Main Trench / Duct). A2 (Diversity Trench / Duct)
ALTERNATIVE 2 - B1 (Main Trench / Duct). B2 (Diversity Trench for OFC only at a depth of 1.70m)
NOTE :-
(i) Diagram is indicative only. Conditions of contract and Employer requirement shall prevail.
(ii) Main / Diversity Trench / Duct shall be as per particular Employer Requirement.
(iii) Separate / Combined Trench / Duct for Telecom / Signaling Cable / Signaling power cable shall be provided as stated in Employer Requirement.
(iv) Suitable RCC / Plastic cable duct may be cast in situ or manufactured in the factory.
(v) A1, B1 shall be located with in DFCC Boundary on the side opposite to IR Track and as far as away from DFCC Track as possible.
(vi) Alternative 2 may be exercised if alternative 1 is not feasible.
(vii) Requirement of IRSEM to be kept in mind.
(viii) These plans should not be used as basis for variation of existing contracts wherein these drawings are not stipulated as part of contract document.
GGM /Signal / Indicative Drawing No.:2

Annexure-3

List of LC Gates between New ERC Mughalsarai- New Durgauti and New Karwandiya - New Chiraillapathu & New Sonnagar

S. No.	LC Gate No	IR Chainage	DFC Chainage
1	3	406/17-13	6350
2	35/C/2-E	556/26-28	6+700
3	36/C/2-T	559/16-18	9+300
4	37/C/2-E	562/12-14	12+200
5	64/C/3-E	630/10-12	80168.487
6	65/C/3-E	633/8-10	83202.483
7	66/C/3-E	637/6-8	87125.432
8	67/C/3-E	638/8-10	88191.399
9	69/C/3-A	642/8-10	92110.173
10	70/C/3-E	644/6-8	94182.433
11	71/C/3-E	645/10-12	95291.122
12	72 A/Spl/2-T	647/24-26	97848.571
13	72/Spl/2-T	649/6-8	99088.782
14	73/B/2-T	649/16-18	99365.07
15	74/C/3-E	651/18-20	101562.25
16	75/C/3-E	653/24-26	103637.852
17	76/C	656/12-14	106161.824
18	76A/3/C/T	657/20-22	107540.341
19	77C	659/14-16	109373.342
20	78C	661/20-22	111498.342
21	80/C/T	665/1-3	114908.45
22	81/C/B	668/1A-3A1	117832.944
23	83B/3T	669/21A-23A	119412.486

Note:
Out of these 23 LC gates, 5 LC gates are planned for elimination by replacement with RUB/ROB. The LC Gate no. which will be eliminated shall be finalized at the design & drawing stage.

Annexure-4

TENTATIVE RULES FOR LC GATE WORKING

Tentative Rules For LC Gate Working Between New ERC Mughalsarai To New Durgauti And New Karwandiya To New Sonnagar (Bagahabishunpur (IR)) & New Chiraillapathu (Chiraillapathu (IR)) When Automatic Block System Of Working On DFC And Absolute Block System Of Working On IR. For Each LC Gate, Gate Working Rule (GWR) Shall Be Approved By IR And Accordingly All S&T Provision To Be Made By System Contractor.

(A) NORMAL POSITION OPEN TO ROAD TRAFFIC:-

1. Normal position of lifting barrier shall be vertical i.e. open to road traffic.
2. All the level crossing gates falling on DFCCIL will be interlocked with signals.
3. Gate signals on the automatic territory of DFCCIL will be semi-automatic and provided with illuminated A marker and a G plate.
4. There will be single gate hut and single gateman to operate the lifting barrier in each shift. An additional gateman/helper will be provided by DFC wherever required.
5. The Gateman shall work under the administrative control of Railways.
6. The booms shall be interlocked with the gate signal on DFC as well as IR system and wherever required, gate signal and automatic signal on DFC will be clubbed.
7. Single set of Electrically operated common lifting barriers(IRS :S-41/70 from RDSO approved source only) shall be provided outside both the Railway and DFCCIL track so as to protect both the Railway as well DFCCIL track by one set of booms.
8. A common indication panel shall be provided in the gate hut, where indication for the `On` and `Off 'aspect of gate signals for both the system as also the occupation/clearance of the controlling track circuit up to the point of approach warning shall be displayed. Direction of movement of the train shall also be displayed in the panel.
9. A separate panel for the operation of the booms shall also be provided where in the buttons for raising/ lowering of booms as also for stopping them midway during operation shall be provided so that the booms can be stopped midway during operation, should a vehicle under the boom or inter the level crossing gate during the process of closure.
10. Arrangement for manual emergency operation of booms shall also be provided which can be used when it not possible to close or open the booms electricity due to some defect or otherwise.
11. Colour light road signals as well as hooter shall be provided by DFCCIL 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.
12. Telephone with selective ringing arrangement shall be provided between Gate man and IR Station Master as well as between the Gate man of the adjacent gate.
13. As soon as the train reaches a predetermined point in rear of the gate, a buzzer will start sounding in the gate hut intimating the gateman of the approach of the 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 an approaching train. At this time, 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.
14. Another warning buzzer shall also sound when the train reaches a distance of 4 kms on DFCCIL and 2 kms on the IR system. At this stage, if the gate is in closed position, approach 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. Subsequently, the gate signal shall assume 'OFF' aspect.
15. After passage of the train from the level crossing, the gate man 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.

16. Arrangement for fixing of safety chain and hand operated Safety boom or sliding boom shall be provided for use in case of failure of lifting barriers. Indication for fixing of safety chain and hand operated booms shall also be provided for taking 'OFF' the relevant gate signal when the safety chain and hand operated boom is properly locked and defected by the system. In this case, the gate shall display 'Yellow' aspect.

17. Procedure for closer of the gate;

(i) For train on DFC system:-

Intimation regarding approach of a train towards the level crossing shall be conveyed to the gateman through the system itself track circuit by sounding of the buzzer as also track circuit indication available on the gate panel.

(ii) For trains on the IR system:-

AS soon as a train leaves the station in rear on IR system, the Station Master shall intimate the gateman that the train has left. If, however, the running of the train from station in rear 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 his 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 4 kms on DFC/2 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 the train from the level crossing, the same shall be opened to pass the road traffic after ensuring from the track indication on the indication panel that there is no train either on DFC or IR track.

(B) NORMAL POSITION CLOSED TO ROAD TRAFFIC

Whenever the gate is required to be opened for the passage of Road traffic, the following action shall be taken by the gateman:-
The gateman shall open the gate for the passage of the road traffic when no train is anticipated on the DFC as well as IR system by checking from the indication panel.

(i) The position of the train on DFC as well as IR tracks shall be known to the gateman from the indication panel.
(ii) 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 DFC/IR track.
(iii) After passage of 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.

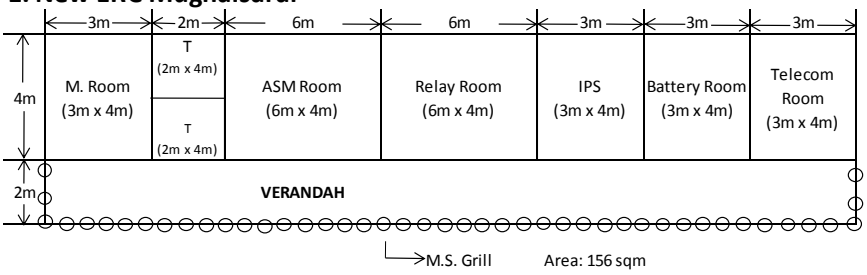
Note:-Para No. 1 to 16 is same as in case of Normal position is Open to road traffic.

- End of Annexure 4 –

Annexure-5

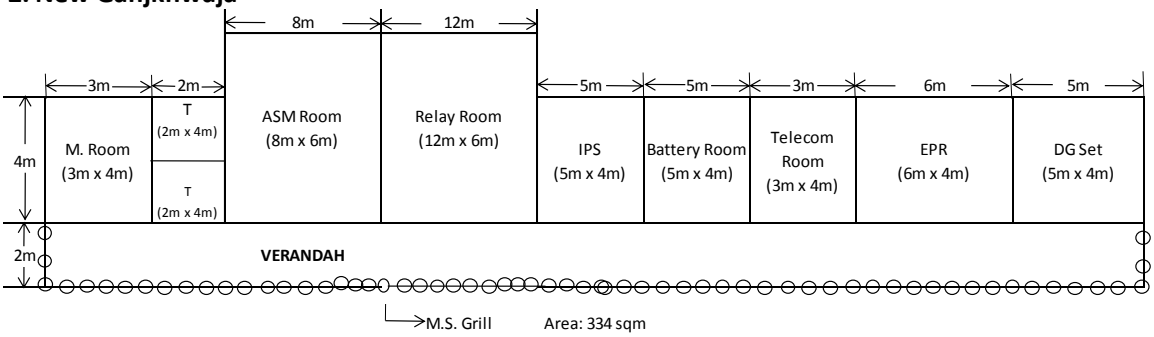
Tentative Station Building Plan

1. New ERC Mughalsarai



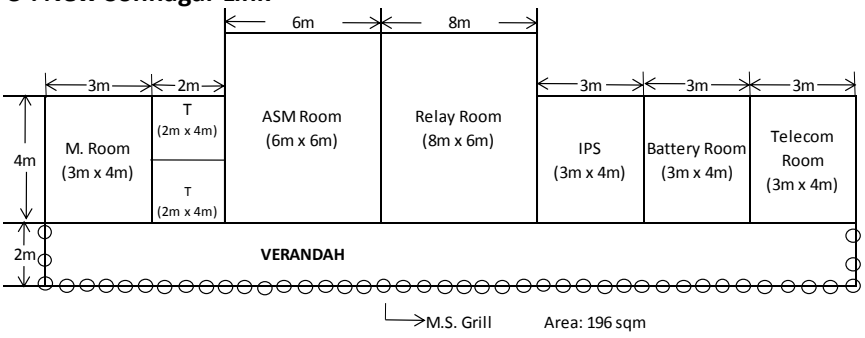
Area: 156 sqm

2. New Ganjkhwaja



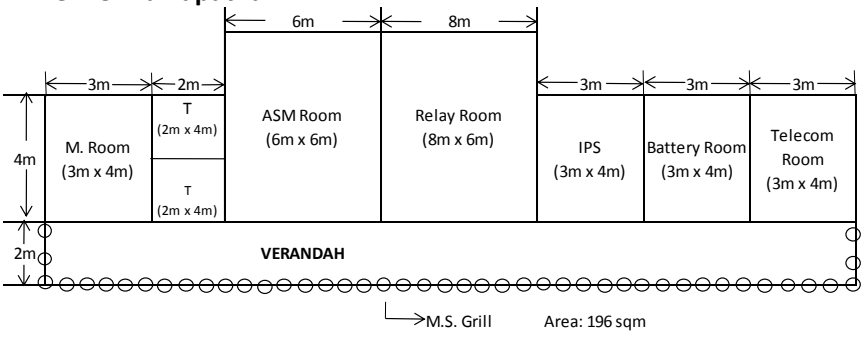
Area: 334 sqm

3-. New Sonnagar Link



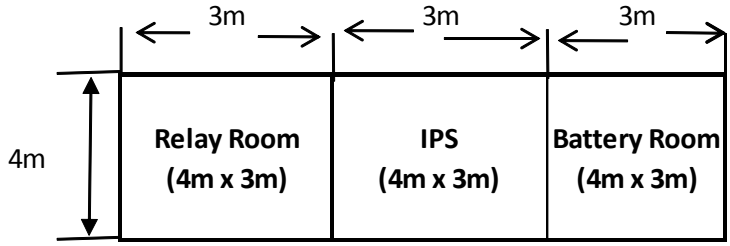
Area: 196 sqm

4. New Chiraillapathu

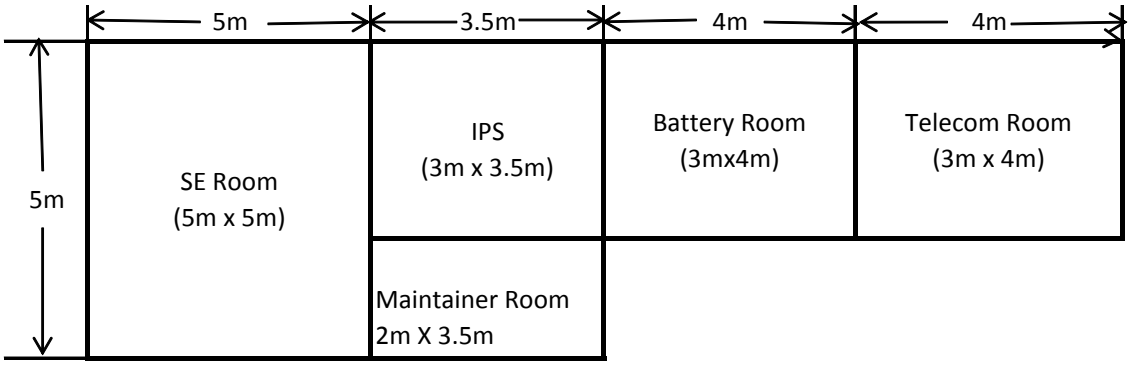


Area: 196 sqm

Tentative LC Gate Goomty Building Plan



Tentative Auto location Hut Building Plan



BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, INSTALLATION OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILLAPATHU STATION (EXCLUDING NEW KARWANDIYA-NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

SYSTEM WORKS CONTRACT PACKAGE

Issued on: 29.12.2017

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

EMPLOYER'S REQUIREMENT

Part -2, Section-V (B), Volume-8

Particular Specifications-Telecommunication Works

EMPLOYER:

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD

(A GOVERNMENT OF INDIA ENTERPRISE)

Under

MINISTRY OF RAILWAYS

TABLE OF CONTENTS

LIST OF DEFINITIONS

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

Definitions	Descriptions
Availability	The probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that the given external resources are provided.
Corrective Maintenance	Maintenance performed to correct the occurrence of an equipment or system fault.
Dark Fibre	An available, un-switched optical fibre.
Line Replaceable Unit (LRU)	Equipment that can be replaced as a single complete unit and can be handled by a single person.
Man Machine Interface (MMI)	The visual interface between the Controller and the control system. The MMI consists of the computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.
Mean Time To Restore (MTTR)	The average time to restore equipment, subsystems, systems to full functionality.
Operating Hours	Operating hours for Train Operation in EDFC shall be 24 Hours all days.
Possession	Taking a section of the line out of service for engineering purposes.
Reliability	The measure of ability to rely upon equipment and systems to perform their intended function. The measure of reliability is MTBF.
Safety-Critical	Failure of the system, sub-system or equipment will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.
Sub-system	Any one of the sub-systems comprising the Telecommunication System; i.e. OFC System, Telephone System, VHF communication System, Direct Line & Emergency Communication System, Master Clock System, 48 volt DC Battery Backup System, Lightening, Surge Protection and Earthing System, and Videos Surveillance System for TSS/RSS.
Train Description	An alphanumeric sequence uniquely identifying a running train.
Train Operator/Driver	The person on the train responsible for its operation.
Workstation	The collection of processors, screens and input devices necessary to provide one Controller with the necessary System displays and Commands.
Pull-down Menu	A list of items displayed by clicking mouse, arranged in the downward direction.
Pull-up Menu	A list of items displayed by clicking mouse, arranged in the upward Direction.
Class B Station	Class B Stations as defined in Indian Railway General Rules. Under this Contract Class B Stations will be New Sonnagar.
Class Special Station	Class Special Stations as defined in Indian Railway General Rules. Under this Contract Class Special Stations will be New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, and New Chiraillapathu.
Stations	Stations include Class B Stations New Sonnagar and Class Special Stations New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Chiraillapathu.

ABBREVIATIONS

ADM	Add Drop Multiplexer
ALARP	As Low As Reasonably Practicable
ASP	Audio and Selection Panel
ATP	Automatic Train Protection
BHCA	Busy Hour Call Attempt
BLSR	Bi-directional Line Switched Ring
BOQ	Bill of Quantity
CBS	Cell Broadcast Service
CD	Commercial Dispatcher
CENELEC	European Committee for Electro-technical Standardization
CI	Cell Identifier
CISPR	International Special Committee on Radio Interference
CLIP	Calling Line Identification Presentation
CILR	Calling Line Identification Restriction
C/I	Carrier to Interference Ratio
CLK	Clock System
CS	Control Superintendent
CSMA/CD	Carrier Sense Multiple Access / Collision Detection
CSS	Central Security System
CTCSS	Continuous Tone coded Squelch System
DCS	Digital Coded Squelch
DDF	Digital Distribution Frame
DGON	New Durgauti Station
DI	Digital Input
DID	Direct Inward Dial
DOD	Direct Outward Dial
DOT	Department of Telecommunication, Ministry of Communication & Information Technology, Govt. of India
DLP	Defect Liability Period
DLT	Direct Line Telephone
DTMF	Dual Tone Multiple Frequency
DTS	Data Transmission System
DWC	Double Wall Corrugated
ECS	Environmental Control System
EDFC	Eastern Dedicated Freight Corridor
EIR	Equipment Identification Register
EIRENE	European Integrated Railway Radio Enhanced Network
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMLPP	Enhanced Multi level Precedence and Pre-emption Service
E&M	Ear and Mouth
EoS	Ethernet over SDH
EPABX	Electronic Private Automatic Branch Exchange
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
ETSI	European Telecommunication Standards Institute
FAT	Factory Acceptance Tests

FASW	Fast Ethernet Access Switch
FEP	Front End Processor
FRS	Functional Requirement Specification
FXS	Foreign Exchange Subscriber
FXO	Foreign Exchange Office
GI	Galvanized Iron
GOS	Grade Of Service
GPS	Global Positioning System
GUI	Graphical User Interface
HCS	Hundred Call Seconds
HDLC	High Level Data Link Control Protocol
HDPE	High Density Poly Ethylene
IAP	Integrated Audio Panel
ID	Identification
IDC	Insulation Displacement Connection
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
EN	European Norm
ECV	End Cell Voltage
IP	Internet Protocol
IR	Indian Railway
ICT	Information and Communication Technology
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunications Union – Telecommunication Standardization
ITU-R	International Télécommunications Union – Radio communication Sector
KWDN	New Karwandiya Station
LAN	Local Area Network
LAS	Link Assurance Signal
LC	Level Crossing
LCD	Liquid Cristal Display
LCP	Local Control Panel
LCX	Leaky Coaxial Cable
LED	Light-Emitting Diode
MDF	Main Distribution Frame
MEP	Mechanical Electrical Planning
MLPP	Multi Level Precedence and Pre-emption Service
MMI	Man Machine Interface
MS	Mobile Subscriber
MS-SPRING	Multiplex Section Shared Protection Ring
MTBF	Mean Time Between Failure
MTTR	Mean time To Repair
NMS	Network Management System
NTP	Network Time Protocol
O&M	Operating and Maintenance
OA	Office Automation
OCC	Operation Control Centre
OCS	Overhead Contact System
ODF	Optical Distribution Frame
OEM	Original Equipment Manufacturer
OSI	Open System Interconnection
OFC	Optical Fibre Communication

OMS	OTN Management System
PABX	Private Automatic Branch Exchange
PAL	Phase Alternation by Line
PC	Personal Computer
PCM	Pulse Code Modulation
PDH	Plesiochronous Digital Hierarchy
PI	Pulse Input
PIJF	Polyethylene Insulated Jelly Filled
PLC	Programmable Logic Controller
PSTN	Public Switched Telephone Network
PTT	Press To Talk
UPSR	Uni-directional Path Switched Ring
RAMS	Reliability Availability Maintainability & Safety
RDSO	Research Design & Standards Organization, Ministry of Railways, Govt. of India
REC	Railway Emergency Call
RE	Railway Electrification/Electrified
RF	Radio Frequency
RMON	Remote Monitoring
RSI	Repetitive Strain Injury
RTU	Remote Terminal Unit
SAT	System Acceptance Tests
SC	Station Controller
SCADA	Supervisory Control and Data Acquisition
SCR	Station Control Room
SDH	Synchronous Digital Hierarchy
SIL	Safety Integrity Level
SINAD	Signal to Noise and Distortion sensitivity
SM	Single Mode
SMS	Station Management System
SMS	Short Message Service
SMSC	Short Message Service Centre
SNCP	Sub-network Connection Protection
SONET	Synchronous Digital Network
SP	Sectioning Post
SR	Space Radio
SSP	Sub-Sectioning Post
SRS	System Requirement Specifications
STM	Synchronous Transport Module
TBC	Train borne Communications
TCCP	Train Cab Communication Panel
TCP/IP	Transfer Control Protocol/Internet Protocol
TD	Traffic Dispatcher
TDMA	Time Division Multiple Access
TER	Telecommunication Equipment Room
TFT-LCD	Thin Film Transistor – Liquid Cristal Display
TMS	Train Management System
TRAU	Trans-coding Rate Adaption Unit
TRX	Transceiver
TSS/TPSS	Traction Power Sub-Station
UMTS	Universal Mobile Telephone System
UPS	Uninterruptible Power Supply
UTC	Universal Time

VBS	Voice Broadcast Service
VCC	Vehicle Communication Controller
VDU	Video Display Unit
VHF	Very High Frequency
VoIP	Voice over IP
VLAN	Virtual Local Area Network
VLR	Visitor Location Register
VMS	Voice Mail Service
VMS	Voice Mail System
VRLA	Valve Regulated Lead Acid
VRS	Voice Recording System
VSWR	Voltage Standing Wave Ratio
WAN	Wide Area Network

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	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 or Latest	Control Communication System shall have equipment as per RDSO specs
IRS: TC 30-05 or Latest	RDSO Specifications for 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
IRS: TC 41-97 or Latest	RDSO Specifications for Polythene Insulated Jelly Filled Cable
IEC 60950	Safety of Information Technology Equipment
IEC 60364	Electrical Installations of Buildings
EIA/TIA–222-E	Antenna Tower at Radio Base Station

IS 800,808, 226/2062/ 1367,1161, 2629,5358	
IS 4759	Hot dipped galvanized iron compliance for towers
IEEE 802.3af	PoE
RDSO/SPN/TL/23/99 Ver 4.0 or Latest	RDSO Specifications for Battery Chargers
RDSO Spec: IRS: S93-96 TEC Spec: GR/BAT-01/03 March 2004	VRLA battery cells
ITU-T Rec. G.652	ODF: Optical connectors compliance
IEC 62305 IEC 62561 IEC 60364	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 (PCM) channels.
ITU-T Rec. G.821	ITU-T Recommendation on Error performance of an international Digital Connection.
IRS: TC 55-2006 or Latest	RDSO specification for 24 F Armoured Optical Fibre Cable.
IEC 60793 & IEC 60874	IEC Specification for Optical Fibres and Connectors.

1. INTRODUCTION

1.1 Scope and Purpose

1.1.1 This Specification covers the Design, Manufacturing, Delivery, Installation, Testing & Commissioning and Defect Liability Period Support for the Telecommunications System to be supplied under this Contract.

1.1.2 The Telecommunications System comprises of subsystems including Optical Fibre Communication (OFC) System, VHF Communication System, Telephone System, Direct Line & Emergency Communication System and Master Clock System, Lightening, Surge Protection and Earthing System, Video Surveillance System for TSS/RSS.

1.2 Relevant Documents

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

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

1.2.3 In the event of a conflict between the PS and any other standards or specifications quoted in the PS, the requirements of the PS shall prevail.

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

End of Chapter 1

2. SCOPE OF THE WORKS

2.1 General Requirements

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

2.1.2 The Telecom Systems shall comprise but not limited to the following Major Sub systems:

1. Optic Fibre Communication (OFC) System
2. Telephone System.
3. VHF Communication System.
4. Direct Line & Emergency communication System
5. Master Clock System
6. 48 V DC Battery Backup System.
7. Spares, special Tools and Test Equipment
8. Lightening, Surge Protection and Earthing System
9. Video Surveillance System for TSS/RSS

2.1.3 The Telecom Systems, as given above at Para 2.1.2 being provided under this contract shall be integrated with Telecom Systems under system contract Package of New Durgauti-New Karwandiya Section, CP-203 Bhaupur – Mughalsarai section, CP-104 Khurja – Bhaupur section, OCC at Allahabad under CP-104 of EDFC

2.1.4 All the control circuits of New ERC Mughalsarai to New Sonnagar and New Chiraillapathu section including New Durgauti-New Karwandiya Section which is at present in temporary OCC at Mughalsarai, DRM Office shall be extended/ shifted to OCC at Allahabad by seamless integration with CP-203. This integration shall be in the present scope of contract.

2.1.5 The scope shall also include any extension/upgradation/augmentation/reconfiguration, as required for Integration as per Para 2.1.3, of equipment provided under system contract Package of New Durgauti-New Karwandiya Section, CP-203 Bhaupur – Mughalsarai section, CP-104 Khurja – Bhaupur section, OCC at Allahabad under CP-104 of EDFC. If required, new system shall be provided for the Integration.

2.2 Scope of Supplies

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

2.3 Scope of Services

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

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

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

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

2.5 Contractor's Responsibility for Discrepancy:-

2.5.1 All designs and drawings submitted by the contractor shall be based on a thorough study and shall be such that the contractor is satisfied about their suitability. The Engineer's approval will be based on these considerations, notwithstanding the approval Communicated by the Engineer, during the progress of the contract for designs and drawings, prototype samples of components, materials and equipment after inspection of materials, after erection and adjustments to installations. The ultimate responsibility for correct design and execution of work shall rest with the contractor.

2.5.2 The contractor shall be responsible for and shall bear and pay the costs for any alteration of works arising from any discrepancies, errors or omissions in the design and drawings supplied by him, whether such designs and drawings have been approved by the Engineer or not.

End of Chapter 2

3. PERFORMANCE REQUIREMENTS

3.1 General

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

3.1.2 The System shall be so designed as to have a minimum of 15 years of service life operating continuously. The life of all the cables including Optical Fibre Cables, Jelly Filled Telecom 6-Quad Cable, Telephone Cables, RF Cables and shall not be lower than 25 years. Life of Radio Towers/Mast shall not be less than 40 years.

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

3.2 Reliability Requirements

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

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

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

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

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

3.3 Availability Requirements

3.3.1 Detailed availability requirements for individual sub-systems are given in 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 during Defects Liability Period (DLP) shall not exceed 2 hours. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at 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 response time.

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

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

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

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

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

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

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

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

3.4.11 The Maintainability Plan shall identify a comprehensive list of maintainability-related submissions such as specifications, standards, method statements, procedures, drawings, and records to the Engineer for review. 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 No toxic or asbestos-containing materials shall be used anywhere in the System.

3.6 Electromagnetic Compatibility (EMC)

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

3.6.2 The maximum levels of out-of-band emission shall be such as to ensure that the subsystems perform in conformity with the criteria given in the respective Chapters of the PS.

3.6.3 The maximum levels of radiated and conducted EMI of the System shall not exceed the levels specified in EN50081-1.

3.6.4 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 IEC61000-4-2.

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

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

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

3.6.8 Inter-system EMC

(1) The contractor shall ensure that all equipments are designed and constructed in accordance with latest versions of EMC standards including but not limited to EN50082, EN50121, EN 50123, EN50155, IEC60571, IEC61000 or equivalents to ensure proper functioning

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

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

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

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

3.6.10 Environmental EMC

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

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

End of Chapter 3

4. DESIGN REQUIREMENTS

4.1 General

4.1.1 Design Approach

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

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

(1) Field proven with past successful applications references

(2) Conforming to open international standards

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

4.1.1.4 The Contractor shall submit a Design Plan. The design shall be in minimum two stages of Preliminary and Definitive Design.

4.1.2 Design Verification and Validation

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

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

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

(1) Estimation of the power consumption and heat dissipation per equipment location
(2) Prediction of the reliability and availability of the Subsystem.

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

4.1.3 Design Review

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

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

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

4.1.3.4 The following issues shall be addressed during Design Review Meetings:

(1) Design Progress
(2) Interface Issues

4.1.4 MMI Design

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

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

4.1.5 Submission of Samples

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

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

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

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

4.2 Equipment Design

4.2.1 General Considerations

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

4.2.1.2 All active equipment shall have LED indications indicating:

(1) Normal operating conditions
(2) Normal power supply
(3) Alarm conditions

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

4.2.1.4 RDSO approved communication system (selective calling) between adjacent LC Gate, controlling IR station and both DFC station of concern automatic block section shall be provided and also comply the provision of communication for LC Gate working shall be as per Gate working rule as approved by IR & CRS.

4.2.2 Fire and Smoke Precautions

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

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

4.2.2.3 All necessary measures shall be adopted to prevent the creation of hazardous conditions arising out of overheating and/or ignition of cables.

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

4.3 Environmental Conditions

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

4.3.2 Unless otherwise specified, all telecommunication equipment shall be designed for operation continuously in temperatures of -5^{O}C to $+55^{O}$C.

4.3.3 Suitable means to regulate temperature and maintain air-circulation (with 1+1 redundancy) at all Telecommunication Equipment Rooms & Power Supply Rooms at Station Buildings, Auto location huts and LC Gate Goomty within limits shall be provided so as to facilitate proper working of electronic equipment and VRLA battery as summer time temperature inside the equipment room is likely to reach very high levels. Status of temperature of Stations, Auto location huts and LC Gate Goomty and functioning of the temperature-regulator equipment and air-circulation equipment shall be monitored and recorded through Data Logger.

End of Chapter 4

5. OPTICAL FIBRE COMMUNICATION 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 Section Locations, LC Gates, TSS/RSSs, SPs, SSPs, 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 (latest version) 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 outside this Contract and shall provide an additional spare bandwidth of at least 50% of the total used bandwidth for future system expansion.

5.1.4 This OFC System being provided under this contract shall be integrated with OFC System being provided under System Contract of New Durgauti-New Karwandiya section, Contract Package CP–203 for Mughalsarai to New Bhaupur section of EDFC and Contract Package CP-104 for Bhaupur-Khurja section of EDFC.

5.1.5 Whenever existing equipment provided under System Contract of New Durgauti-New Karwandiya section, Contract Package CP-104 and Contract Package CP-203 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.

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) Optical Fibre Transmission Equipment;
(2) STM Multiplexers;
(3) Flexible Access Multiplex equipment;
(4) Network Management System for OFC System;
(5) All software and licenses;
(6) Single Mode Optical Fibre Cables;
(7) Splice Boxes and remake loops;
(8) Distribution Frames;
(9) Terminating and interconnecting equipment including Termination Protection Devices;
(10) Equipment cabinets, racks and cubicles;
(11) All required connectors;
(12) Installation materials;
(13) Power supply and all other data cables, earthing and accessories including termination protection devices;
(14) Spares; and
(15) Test Instruments and Tools.

5.3 System Requirements

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

5.3.2 The OFC System shall support voice, data and video signal transmission between various locations and modes of transmission shall include, but not 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 back bone networks. Each of the two optical fibre cable networks shall be formed by two outdoor single mode optical fibre cables. The normal and protected routes shall be routed through different fibre cables with route diversity.

5.3.3.2 The First Network shall be formed by two OF cables, preferably one laid along the up-track and the other laid along the down-track ensuring route diversity.

Under System Contract for Durgauti-Karwandiya section Optical Fibre Cable for First Network has been laid from New Durgauti to New Karwandiya. Under this Contract Optical Fibre Cable of First Network shall be laid from Mughalsarai to New Durgauti and from New Karwandiya to New Sonnagar & New Chiraillapathu.

Optical Fibre Cables of the First Network shall be terminated in ODFs in TERs at Mughalsarai (EDFC-2), New GanjKhwaja, New Durgauti, New Karwandiya, New Sonnagar Link, New Chiraillapathu, New Sonnagar and any other locations if required. The First Network provided under this system contract shall be integrated with the First Network of New Durgauti-New Karwandiya section and also with the First Network being provided under Contract Package CP-203.

5.3.3.3 Under System Contract for New Durgauti- New Karwandiya section Optical Fibre Cable for Second Network has been laid from New Durgauti to New Karwandiya. Under this Contract Optical Fibre Cable of Second Network shall be laid from Mughalsarai (EDFC-2) to New Durgauti and from New Karwandiya to New Sonnagar & New Chiraillapathu.

The Optical Fibre Cables of the Second Network shall be terminated in ODFs at TERs at Mughalsarai (EDFC-2), New ERC Mughalsarai, New GanjKhwaja, New Durgauti, New Karwandiya, New Sonnagar Link, New Chiraillapathu, New Sonnagar, ERC Mughalsarai (IR), GanjKhwaja (IR), Bagahabishunpur (IR), Chiraillapathu (IR), Auto Section Locations, LC Gates, TSS/RSS, SP, SSPs, IMDs, Staff Residential Colonies and any other location, if 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 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 Optical fibre cables shall be supplied as per RDSO specification no. IRS: TC 55- 2006 (latest amendment) from RDSO approved sources only.

5.3.3.6 Both the optical fibre cable networks shall have a minimum fibre count of 24 fibres for each of the two cables. At least 50% of fibre within each cable shall be reserved as spares for future use.

5.3.3.7 The Optical Fibre Cables within Station/IMD and along the Track shall be laid along different routes to provide 100% route diversity.

5.3.3.8 The First Network shall carry all Voice & Data Communication between OCC, Class B Stations and Class Special Station of DFC. The First Network shall also carry all Train Management System information and other Vital & Safety Related Information between OCC and DFC Stations (Class B Station & Class Special Stations). All Vital & Safety Related System using OFC System shall be implemented as per EN-50159.

5.3.3.9 The Second Network shall carry all Voice (including Emergency Communication) and Data (including Traction Power SCADA & Auxiliary SCADA) Communication between DFC Stations (Class B Station & Class Special Stations), ERC Mughalsarai (IR), GanjKhwaja (IR), Bagahabishunpur (IR), Chiraillapathu (IR), Auto Section Locations, LC Gates, IMD, TSS, SP, SSPs, Staff Residential Colonies and any other location, if required.

The Second Network shall also carry all Signal Control Information, Track Vacancy Detection Information and other Vital & Safety Related Information between DFC Stations(Class B Stations & Class Special Station), ERC Mughalsarai (IR), GanjKhwaja (IR), Bagahabishunpur (IR), Chiraillapathu (IR), Auto Section Locations and LC Gates. All Vital & Safety Related System using OFC System shall be implemented as per EN-50159.

5.3.3.10 Optical fibre cables terminated at the Optical Distribution Frame (ODF) shall be either spliced through or spliced with optical pigtails or terminated at the optical patch panels including the spare fibres. ODFs shall be provided in the TERs at all the locations.

5.3.3.11 At least 15 metres slack in each optical fibre cable at all equipment rooms shall be reserved for future network modification and expansion before taking cables to ODFs.

5.3.3.12 Optical Fibre Cable shall also be laid from SER/TER of Stations/Auto Section Locations to Field Units/Track Devices of Track Vacancy Detection System, as required, to meet the requirements of Particular Specifications-Signalling Works.

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 network to form the SDH Network of the OFC System. The SDH Network shall provide dual and self-healing protected transmission paths.

5.3.4.2 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 Subsystems under this Contract as well as Communication Requirements of-New Durgauti-New Karwandiya Section and 50% Spare Capacity. SDH Node of First Network shall be equipped with minimum 2XSTM-16o and 4XSTM-4o interfaces.

STM-16 Nodes provided at New Durgauti & New Karwandiya by the System Contractor of DGON-KWDN and STM-16 Nodes provided at New Sonnagar link & New GanjKhwaja provided by this System Contractor shall be of Cross Connect Type. The SDH Nodes of New Durgauti & New GanjKhwaja shall be connected to each other and SDH Nodes of New Karwandiya & New Sonnagar Link shall be connected to each other at STM-16o level in redundant architecture with Linear Multiplex Section Protection or SNCP by extending ring being provided under System Contract of DGON-KWDN. The STM-16 Nodes provided at New Durgauti & New Karwandiya under System Contract of DGON-KWDN shall be upgraded/augmented, if required, for above integration.

Similarly, STM-16 Node provided at Mughalsarai by Contractor and STM-16 Node provided at Mughalsarai (DFC station) under Contract Package CP-203 shall be of Cross Connect Type. These SDH Nodes shall be connected to each other in redundant architecture with Linear Multiplex Section Protection. The STM-16 Nodes provided at Mughalsarai under Contract Package CP-203 shall be upgraded/augmented, if required, for above integration.

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 System Contract of DGON-KWDN and Contract Package CP-203 to meet the requirement of various systems/subsystems under this Contract as well as under System Contract of DGON-KWDN and Contract Package CP-203.

5.3.4.3 The Second Network shall carry all Voice (including Emergency Communication) and Data (including Traction Power SCADA and Auxiliary SCADA) Communication between all DFC Stations including DGON-KWDN section, Auto Location Huts, Interfacing IR Stations, LC Gates, TSS, SSPs, IMSD, and Staff Quarters etc.

The Second Network shall also carry all Signal Control Information, Track Vacancy Detection Information and other Vital & Safety Related Information between DFC Stations of this section including DGON-KWDN, Auto Location Huts, and Interfacing IR Station. All Vital & Safety Related System using OFC System shall be implemented as per EN-50159.

5.3.4.4 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 for relevant Project Contractors and 50% Spare Capacity. SDH Node of Second Network shall be equipped with minimum 4XSTM-4o Interfaces.

5.3.4.5 SDH Nodes at DFC Stations shall be common for First & Second Network and equipped with Digital Cross Connect at VC4, VC3 and VC12 levels.

5.3.4.6 SDH Traffic of Sections under this Contract and New Durgauti-New Karwandiya Section shall be carried over to OCC using dedicated VC4s over First Network being provided under the Contracts CP-104 and CP-203.

5.3.4.7 SDH Node at New Chiraillapathu shall be provided with additional 2XSTM-16o interfaces for their future integration with SDH Network of Sonnagar-Dankuni section of EDFC.

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

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

5.3.4.9 Control/Processor Card (if its failure, results in affecting traffic), Switch/Matrix Unit & Power Supply Modules of SDH Equipments shall be provided with 1+1 Protection.

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:

(1) STM optical and electrical signals of same/lower levels;
(2) 2Mbps or the E1 tributaries;
(3) 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.

5.3.5.3 The SDH Nodes of First Network shall be equipped with minimum 8 Ethernet 10/100 Base T tributaries. SDH Nodes of Second Network (excluding at Stations) shall be equipped with minimum 4 Ethernet 10/100 Base T tributaries.

5.3.5.4 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.

5.3.5.5 Flexible Access Multiplexers or Primary Order Multiplexer shall be provided to connect to the 2Mbps tributaries of the SDH node for direct access of channel circuits with data rate lower than 2Mbps.

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

5.3.5.7 The OFC System shall provide Voice and Data Communication Network/Channels/Circuits or bandwidth for the following systems but not limited to:

(1) 2 Mbps E1 (ITU-T G.703 and G.823) Channels for the Telephone System;
(2) Other Data Circuits or Ethernet 10/100 Mbps Ports as required for Traction Power SCADA, Hot Axle Detection etc.
(3) Separate channel of 100 Mbps with redundancy for each of traction SCADA, Auxiliary SCADA & Video Surveillance for entire New ERC Mughalsarai to New Sonnagar & New Chiraillapathu section this includes existing SCADA of New Durgauti-New Karwandiya section also.
(4) Other Data Circuits or Ethernet 10/100 Ports or 4W E&M Circuits or bare fibres for Vital & Safety Related Signal Control Circuits including Track Vacancy Detection.
(5) Sub 2Mbps Voice Circuits for Direct Line Communication System, LC Gate Communication, Emergency Communication, Auto Signal Hut Communication and TSS/SP/SSP Communication.
(6) Other Data Circuits or Ethernet 10/100 Mbps Ports as required for TMS.
(7) Ethernet Connections for each application need to be implemented through Ethernet Virtual Private Line Service.
(8) The OFC System also needs to provide a bandwidth management tool to ensure sufficient transmission capacity for each application to function under all traffic circumstances on the OFC System.

5.3.6 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;

(1) Master Clock Equipment;
(2) An internal clock of the SDH Equipment;
(3) Incoming STM Signal;
(4) 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 Transmission Network nodes.

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 Equipments shall support Protection Mechanism such as Linear Multiplex Section Protection, Sub Network Connection Protection (SNCP), Multiplex Section Shared Protection Ring (MSSP Ring).

5.3.7.2 Path Protection implementation through SNCP is preferred. SNC Protection shall be provided at VC-4, VC-3 and VC-12 level. Signal transmission shall be protected on 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. Manual Protection Switching shall be initiated by a switch command from the NMS. The protection switching shall be completed within 50ms.

5.3.7.5 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.

5.3.7.6 The Flexible Access Multiplex Equipment shall be provided with 1+1 Redundancy for all Channel levels (Voice, Data, etc). Further redundancy of Control & Power Supply Modules/Cards shall also be provided to ensure that a single failure shall not affect the availability of the Flexible access multiplex equipment.

5.3.7.7 No single failure shall affect the availability of OFC System or the Interfaces.

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

5.3.8 Service Telephone / Order Wire

5.3.8.1 A Service Telephone/Engineers Order Wire with handset shall be provided at each SDH node location for point to point and multipoint voice communication calls between maintenance staff at different node locations. It shall permit selective and group call functions.

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

5.3.9 Network Management System

5.3.9.1 At OCC, a Network Management System (NMS) shall be provided to carry out Real-Time centralized and remote monitoring and measurement of network status and performance, and the ability to take prompt action to control the flow of traffic when necessary.

5.3.9.2 The equipment to be managed shall include SDH Equipment, Flexible Access Multiplexer or Primary Order Multiplexers and Optical Line Terminals, etc.

5.3.9.3 NMS Workstation shall be installed at the OCC in TER for the operation of the NMS. In addition, NMS for DGO-KWDN Section provided at Temporary OCC at Mughalsarai shall be shifted to OCC at Allahabad.

5.3.9.4 NMS provided under System Contract of DGON-KWDN section at temporary OCC at Mughalsarai shall be upgraded and shifted to OCC at Allahabad to meet the requirement under this Contract. If required, new system shall be provided for the integration of this section including DGON-KWDN section.

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

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

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

5.3.9.8 The mass storage device shall provide facilities for downloading the configuration and alarm data files to CD/DVD/Pen Drive.

5.3.9.9 Laptop Portable Service Terminals (04 numbers) loaded with Network Management Software shall also be provided for maintenance access to the network elements at various node locations.

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

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

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

5.3.11 Alarm and Status Monitoring

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

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

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

(1) Input failure;
(2) Loss of frame alignment;
(3) High error rate alarm;
(4) Loss of pointer;
(5) Loss of synchronisation;
(6) Out of frame alignment;
(7) Alarm indication;
(8) High/low optical power;
(9) High laser bias;
(10) Tributary unit failure;
(11) Power unit failure;
(12) External synchronisation failure;
(13) Mains power failure; and
(14) Any card/ module failure.

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

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

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

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

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

5.3.12 Performance Monitoring

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

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

(1) Laser bias current;
(2) Optical power transmitted;
(3) Optical power received;
(4) Degraded duration in minutes;
(5) Severely error seconds;
(6) Protection switching counts;
(7) Protection switching duration;
(8) Error seconds of the received E1 and above signals; signal level of the received E1 and above signals;
(9) Error free seconds of the received E1 and above signals; and
(10) Bit error rate of the received E1 and above signals.

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

5.3.12.4 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.

5.3.13 Network Configuration and Provisioning

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

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

(1) Frame position allocation;
(2) Interface port allocation;
(3) Low speed (64 Kbit/s & lower) interface cards configuration;
(4) Lower order multiplex time slot allocation and routing;
(5) Higher order multiplex/cross-connect switch configuration;

(6) Logging of circuit routing data logged into configuration database; and
(7) Operators configuration check function prior to main and backup database update.

5.3.14 User Interfaces

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

5.4 Performance Specification

5.4.1 General

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

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

5.4.2 Reliability

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

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

(1) SDH Node Equipment
(2) Flexible Access Multiplexer or Primary Order Multiplexer
(3) Network Management System
(4) Wide Area Network & Local Area Network

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

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

5.4.5.3 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 synchronization 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 Contractor shall estimate and provide the bandwidth needed in order to guarantee the level of service required by all the subsystems.

5.5.2 Technical System Performance

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

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

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

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

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

5.5.2.6 At least 50% Spare Traffic Bandwidth and capacity between nodes shall be provided for SDH Network, Primary Multiplexer Network & Wide Area Network. Spare capacity shall be achieved by providing additional cards and/or modules.

5.5.2.7 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 multiplexers, optical line terminal and data modem.

5.5.2.8 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.

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

(1) Commands presented to the NMS from Management Workstation shall be processed and produce an appropriate output within 2 seconds maximum;

(2) Real-time data presented to the Management Workstation from the network elements shall be processed and produce the appropriate output within 2 seconds maximum; and

(3) Execution of parameter changes to SDH Nodes initiated through the NMS shall be less than 2 seconds.

5.5.3 Equipment Design Requirements

5.5.3.1 General

5.5.3.1.1 The equipment design of OFC 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.

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

5.5.3.1.3 Equipment shall be equipped with protected test points for measurement and performance monitoring without affecting the traffic.

5.5.3.1.4 Test access facilities shall be provided at different transmission levels.

5.5.3.1.5 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

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

5.5.3.2.2 The SDH Nodes at Class B Stations shall provide cross connect capabilities with a granularity of VC4, VC-3 and VC-12. The SDH Nodes at Class B Stations 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.

5.5.3.2.3 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.

5.5.3.3 Flexible Access Multiplex Equipment and Optical Line Terminals

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

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

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

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

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

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

5.5.3.3.7 Flexible access multiplexer equipment shall be provided with 1+1 protection for all channel levels

5.5.3.3.8 The optical line interfaces shall conform to ITU-T Rec. G.957 & G.958.

5.5.3.4 Channel Interfaces

5.5.3.4.1 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 Approval of the Engineer:

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

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

5.5.3.4.3 The Contractor shall submit the details of all the channel interfaces which can be supported by the Flexible Access Multiplexer or The Primary Order Multiplexer.

5.5.3.4.4 The voice interface shall be Pulse Code Modulated (PCM) in A-law as described in

ITU-T Rec. G.711.

5.5.3.4.5 The Flexible Access Multiplex Equipment shall also support/provide data interfaces, including but not be limited to the following, subject to the Approval of Engineer:

(1) 0-19.2kbps synchronous or asynchronous data complying with ITU-T Rec. V.11 (EIA RS-422 or RS-485) interface etc;
(2) 0 up to 100 Kbps selectable asynchronous/synchronous full duplex data transmission complying with EIA/TIA-232-E and V.28 standard;
(3) 64 kbps synchronous data interfaces complying with ITU-T Rec. G.703 unbalance interface;
(4) Nx64 kbps synchronous data interfaces complying with ITU-T Rec. V.11 and V.35 interface;
(5) 2.048Mbps synchronous data complying with ITU-T G.703 unbalance interface;
(6) ISDN Basic Rate Interface with 2B+D channels as defined in ITU-T Rec. I.430;
(7) Primary Rate Interface complying with ITU-T Rec. I.431 interface at 2.048 Mbps (30B+D); and
(8) Any other data interfaces required for other Subsystems.

5.5.3.5 Network Management System Specifications

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

5.5.3.5.2 The NMS shall be equipped with a proven real-time, multi-tasking operating system to support centralised network management of the OFC equipment including both the SDH and PDH equipment.

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

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

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

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

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

5.5.3.6 Cabling and Accessories

5.5.3.6.1 Optical fibre cables shall be supplied as per RDSO specification no. IRS: TC 55- 2006 with latest amendments from RDSO approved sources only.

5.5.3.6.2 The Optical Fibre Connectors shall comply with IEC60793 and IEC60874.

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

5.5.4 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 shall be designed and equipped with all necessary hardware, software and capacity for future additional SDH Equipment and associated Multiplexers and Channel Interfaces.

End of Chapter 5

6. DATA NETWORKING SYSTEM

6.1 General

6.1.1 An extensive Data Networking System shall be provided for meeting the Packet Data Communication requirements of MGS-DGON & KWDN-CPBH-SEBN Sections. Data Networking System, which is a Wide Area Network (WAN), shall, inter-alia, cover OCC, DFC Stations(Class B Station & Class Special Stations), New Durgauti & New Karwandiya Stations, TSS/RSS and IMD.

6.1.2 The Wide Area Network (WAN) shall provide sufficient bandwidth to cater for the Packet Data Communication requirements of various Sub-systems under this Contract as well as outside this Contract. This WAN shall also provide sufficient bandwidth to cater for the Packet Data Communication requirements of MGS-DGON & KWDN-CPBH-SEBN Sections of EDFC for other applications such as Freight Operation Information System (FOIS), Crew Management System (CMS) and Wagon Management System (WMS).

6.1.3 This 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 Networking Loading.

6.1.4 The WAN shall provide a high degree of availability by operating on an independent optical Fibre rings using Optic Fibre Cables laid along Up and Down Track of DFCCIL.

6.1.5 Wide Area Network (WAN) shall be integrated with Wide Area Network (WAN) provided under Contract Packages CP-104, CP-203 and New Durgauti-New Karwandiya Section of EDFC to meet the requirement of this Particular Specifications.

6.1.6 WAN shall comply with internationally recognized Industry Standards & Open System Protocols. The Design of the Wide Area Network (WAN) shall provide a highly Secure System, which shall prevent unauthorized Access and/or Hostile Intrusion.

6.1.7 At Junction Stations and Crossing Stations including stations of DGON-KWDN section, 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.

6.1.8 Network Management System (NMS) for Data Networking System to be provided at OCC shall facilitate configuration, administration, monitoring & troubleshooting of the data networking system. In Addition NMS for Data Networking System for New Durgauti-New Karwandiya section provided at Temporary OCC at Mughalsarai be shifted to OCC at Allahabad.

6.1.9 Contractor shall upgrade/augment NMS provided under System Contract for New Durgauti-New Karwandiya section to meet the requirement of this Particular Specifications.

6.1.10 Wherever, existing equipment provided under Contract Packages CP-104, CP-203 and New Durgauti-New Karwandiya Section are upgraded/augmented to meet the requirements 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 PS.

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 & Layer-2 switches;
(2) Wi-Fi Access Equipment
(3) Distribution Frames;
(4) Terminating and interconnecting equipment including termination protection devices;
(5) Equipment cabinets, racks and cubicles;
(6) All required connectors;
(7) Installation materials;
(8) Network Management System;
(9) Power supply and all other data cables, earthing and accessories including termination protection devices;
(10) Spares shall be supplied in accordance with the stipulations in GS and PS;
(11) Test Instruments and Tools;
(12) Earthing and accessories including termination protection devices;

6.3 System Requirements

6.3.1 WAN shall connect OCC, DFC stations and IMD in Ring Topology using Optic Fibre Cable laid along Up and Down Track of DFCCIL. Further WAN shall connect TSS/RSS with New Durgauti Station in Redundant Linear Topology using Optical Fibre Cable. WAN shall be created using Layer-3 Access Switch. As such Layer-3 Access Switch should be equipped with 4 Nos. 10 GigE Fibre Ports for backbone interconnections.

6.3.2 Layer-3 Switches at New Sonnagar Link shall be integrated with Layer-3 Switches being provided at New Karwandiya Station under DGON-KWDN system contract using 10GigE Fibre Ports with 1+1 Protection or by extending the existing Ring of DGON-KWDN system contract.

6.3.3 Layer-3 Switches at New Ganjkhwaja shall be integrated with Layer-3 Switches being provided at New Durgauti Station under DGON-KWDN system contract using 10GigE Fibre Ports with 1+1 Protection. This system contractor and DGON-KWDN system contractor shall interface with each other and submit jointly, agreed integrated design of Data Network for approval of Engineer.

6.3.4 Layer-3 Switches at OCC shall be integrated with Layer-3 Switches at OCC being provided under contract Packages CP-104 & CP-203 using 10GigE Fibre Ports with 1+1 Protection.

6.3.5 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.

6.3.6 Layer-3 switch shall be provided, in fully duplicated configuration, at each site in (1+1) Hot- Standby Configuration.

6.3.7 Layer-3 Switches at New Chiraillapathu shall be equipped with additional 2 Nos. 10GigE Fibre Ports.

6.3.8 WAN shall be of highly Scalable Design, whilst maintaining Throughput, Quality of Service and Security.

6.3.9 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.

6.3.10 Ethernet Services such as EPL, EVPL & E-LAN shall be extended to Mughalsarai (IR), Ganjkhwaja(IR), Chiraillapathu (IR), Bagahabishunpur (IR) , Auto Section Location, LC Gates, TSS, SP & SSP using EoS (Ethernet over SDH) of OFC System for meeting

the requirements of other Systems within this Contract and outside this Contract as decided by Engineer.

6.3.11 EPL, EVPL, E-LAN, L2PT and VPWS Services of MGS-DGON & KWDN-CPBH-SEBN Sections as well as New Durgauti – New Karwandiya Section 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 Dadri–Khurja, EDFC Phase-1, EDFC Phase-2, MGS-DGON & KWDN-CPBH-SEBN Sections, shall be implemented by the Contractor. Contractor shall submit integrated design for approval of Engineer.

6.3.12 Layer-3 Services such as IPv4 Routing, IPv6 Routing, Border Gateway Protocol(BGP), Intermediate System-to-Intermediate System(IS-IS) Open Shortest Path First(OPSF), 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), routed pseudo wire, 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 systems under this Contract as well as outside this Contract.

6.3.13 Layer-3 Services of MGS-DGON & KWDN-CPBH-SEBN Sections as well as New Durgauti – New Karwandiya Section which are to be carried to OCC, shall be implemented over WAN being provided under this Contract and, if required, over WAN being provided under Contract Packages CP-104 and CP-203.

6.3.14 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 Pseudo wire, IP-VPN (RFC 2547) and Integrated Routing & Bridging which are to be required to be provided across Dadri-Khurja Section, EDFC Phase-1, EDFC Phase-2, MGS-DGON & KWDN-CPBH-SEBN Sections as well as New Durgauti – New Karwandiya Section shall be implemented by the Contractor.

6.3.15 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.

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

6.3.17 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.

6.3.18 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.

6.3.19 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.

6.3.20 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 as mentioned in clause 6.3. 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 tools integration

Contractor may upgrade/augment NMS provided under System Contract for New Durgauti-New Karwandiya to meet the requirement of this Particular Specifications.

6.4 Performance Requirement

6.4.1 General

The following performance requirements for Data Networking System shall be fully complied. This shall be based on fault tolerant design with protections against failure shall be provided 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 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 both 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, Pseudowire 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 Contractor shall comply with the maintainability requirements as specified in Clause 3.4 of this PS.

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 fiber cable, the optical transmitter laser output shall shut down to a safe level as defined by IEC-60825, ITUT-G 783 and 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 Equipments.

6.4.5.4 All metallic enclosures shall be provided with an earth terminal.

6.5 Technical Requirements

6.5.1 Layer-3 Access Switches of WAN should meet following minimum technical requirements.

6.5.2 Layer-3 Access Switches of WAN shall have 24 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, supporting Half Duplex, Full duplex and Auto-Negotiation on each port to optimize bandwidth.

6.5.3 Layer-3 Access Switches shall have minimum of 28 Gbps forwarding bandwidth at Layer-2 and Layer-3 Switching Fabric, a minimum of 8,000 MAC address space and 32 million packets (64 Byte packets) per second forwarding rate.

6.5.4 Layer-3 Access Switches shall be capable of working with DC Power Supply with range of -40 to -54V. Power Supply Module should be redundant & inbuilt in the switch.

6.5.5 All the Layer-3 Access Switches to be mounted on a 19-Inch Rack. All accessories required for this mounting should be supplied by the Contractor.

6.5.6 All Software/Hardware/License supplied along with the Layer-3 Access Switches shall be supplied to the Engineer.

6.5.7 Layer-3 Access 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), 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, Basic IP Unicast Routing Protocols.

6.5.8 Layer-3 Switches shall Support multiple privilege level to provide different level of access on console port and telnet sessions.

6.5.9 Switches shall support Online Software Reconfiguration to implement changes without rebooting.

6.5.10 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).

6.5.11 Layer-3 Switches shall have console port with a RS-232/RJ-45 Interface for configuration and diagnostics purposes.

6.5.12 Layer-2 Access Switch:

Layer-2 Access Switches shall meet the following minimum technical requirements:

6.5.12.1 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.

6.5.12.2 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.

6.5.12.3 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 into the switch.

6.5.12.4 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.

6.5.12.5 All Software/Hardware/License supplied along with the Layer-2 Switches shall be supplied to the Engineer.

6.5.12.6 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.

6.5.12.7 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), 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).

6.5.12.8 Layer-2 Switches shall Support multiple privilege level to provide different level of access on console port and telnet sessions.

6.5.12.9 Switches shall support Online Software Reconfiguration to implement changes without rebooting.

6.5.12.10 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).

6.5.12.11 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 Port Mirroring for Traffic Diagnostics shall be available.

6.6.6 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.

6.6.7 The Contractor shall perform Security Analysis of WAN to demonstrate that all above Network Security Threats has been considered and mitigated.

6.6.8 The Contractor shall get its report on security analysis of data network examined from Cyber Security Expert/Agency approved by the Engineer. The suggestions/recommendations of this Cyber security Expert/agency shall be implemented by the Contractor.

6.6.9 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/Engineer's 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 NMS at OCC shall include 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.

6.10 System Expansion

6.10.1 Wherever the equipment of Data Networking System being provided under Contract Package DGON-KWDN, CP-104 and CP-203 is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

End of Chapter 6

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 shall be integrated with Administrative Telephone Network provided under DGON-KWDN system contract and Administrative Telephone Network provided under contract package CP-203/CP-104 at OCC Allahabad.

7.1.5 Direct Line Telephone Network shall be integrated with Direct Line Telephone Network provided under DGON-KWDN system contract to meet the requirement of this Particular Specification.

7.1.6 Control Communication System shall be provided to meet omnibus voice communication requirement of Traffic Control between OCC and DFC Stations of this section including DGON-KWDN section.

7.1.7 Emergency Communication System shall provide an omnibus communication channel between OCC and all Automatic Signals of this section including DGON-KWDN section.

7.1.8 Existing equipment provided at temporary OCC Mughalsarai under DGON-KWDN system contract shall be upgraded/augmented/reconfigured, system contractor shall shift the equipment to OCC Allahabad and carry out necessary integration with other equipments provided under contract package CP-203/CP-104 at OCC Allahabad. If required, New system shall be provided to meet the technical and performance requirements as stipulated in this Particular Specifications.

7.1.9 Existing equipment provided under DGON-KWDN system contract/CP-203/CP-104 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) Line and Trunk Interfaces;

(3) Direct Line Consoles;

(4) Telephone Sets;

(5) Voice Mail System;

(6) Telephone Network Management System;

(7) Voice Recording System;

(8) Control Communication Equipments;

(9) Emergency Communication Equipments;

(10) Power Supply Equipment, Cables and Accessories; and

(11) 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 for this section including the DGON-KWDN section. System contractor shall integrate satellite PBX of the DGON-KWDN section with the PBX system of this section. The integration PBX system of both sections shall be such that there is transparency throughout the entire Mughalsarai-Sonnagar & Chiraillapathu section.

7.3.2 System contractor shall either provide a new Main PBX at OCC or integrate the satellite PBX system located at DFC stations in the this section including DGON-KWDN section or shall upgrade/augment/reconfigure the main PBX system provided at temporary OCC Mughalsarai and integrate the satellite PBX system of this section including DGON-KWDN section and shift it to OCC at Allahabad. Contractor may also upgrade the PBX system provided under the contract package CP-104/ CP-203 and integrate PBX system of this section including DGON-KWDN section.

7.3.3 Main PBX shall be provided at OCC, while Satellite PBX shall be provided at New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link and New Sonnagar, New Chiraillapathu Station. For integration of DGON-KWDN section, PBX of New Durgauti will be connected with PBX of New Ganjkhwaja and similarly PBX of New Karwandiya shall be connected to PBX of New Sonnagar Link. This Network of Main PBX and Satellite PBX shall be created using 2 Mbps E1 Channels over SDH Network as covered in Chapter-5 of this Particular Specifications. One E1 link shall be taken from New Sonnagar Link to OCC and one redundant E1 link shall be taken from New Ganjkhwaja to OCC. This E1 link will be dedicatedly used for administrative telephone system.

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 Station, TSS/RSS, SSPs, IMD and any other location. Approximate requirements of Telephone Sets, which include Analogue Telephones as well as Digital Telephones, are as given in Annexure 1. 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. All the remaining telephones shall be Analogue Telephones.

7.3.5.3 The telephones at OCC, New Sonnagar Link & New Ganjkhwaja shall be directly terminated at PBX, while telephones at locations other than these shall be either directly terminated at PBX (if feasible) or connected to the PBX via the OFC System.

7.3.5.4 The Contractor shall discuss with the Engineer to agree on the exact location of each Telephone Set.

7.3.5.5 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
(7)	Voice Mail	(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)	Forced Release;	(24)	Music on Hold;

(25)	Speed Dial;

The assignment of the class of service and features to any telephone extension shall be configurable.

7.3.5.6 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 shall also be homogenous with numbering scheme adopted for EDFC under Contract Packages CP-104 & CP-203. The numbering plan shall be discussed with Engineer and implemented only after it is reviewed by Engineer.

7.3.5.7 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.

7.3.5.8 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.

7.3.5.9 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.

7.3.5.10 The Administrative Telephone Network shall have the capacity of ringing up to minimum of three telephone sets connected in parallel.

7.3.6 Voice Mail System (VMS)

7.3.6.1 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. Contractor shall upgrade Voice Mail System (VMS)

provided under DGON-KWDN system contract at Temporary OCC at Mughalsarai and shift the same to OCC at Allahabad or upgrade /augment/reconfigure the VMS system provided under Contract Package CP-203 /CP-104 to meet the requirements of this Particular Specification. If required, new system shall be provided for the integration of this section including DGON-KWDN section at OCC.

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 DFC Stations of this section including DGON-KWDN section, IR Sectional Control Centres along the DFC Route, IMD 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 (SC) at DFC Stations of Mughalsarai-Sonnagar section (including DGON-KWDN section), Switching 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 DFC stations i.e. New ERC Mughalsarai, New GanjKhwaja, New Sonnagar Link, New Sonnagar, New Chiraillapathu and with New Durgauti , New Kudra and New Karwandiya (which are part of system contract of DGON-KWDN) with one touch button dialing;

(6) between DFC stations i.e. New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Sonnagar, New Chiraillapathu and Interfacing Station Master Room of Indian Railway with one touch button dialing;

(7) Between IMD and Station Control Rooms of adjacent stations with one-touch button dialing.

7.3.7.2 The Direct Line Telephone Network shall be built using PBXs at OCC and DFC stations of entire Mughalsarai-Sonnagar section. 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 System contractor shall integrate Direct Line Telephone Network of the DGON-KWDN section with the Direct Line Telephone Network of this section. The integration Direct Line Telephone Network of both sections shall be such that there is transparency throughout the entire section.

7.3.7.4 System contractor shall upgrade/augment/reconfigure the existing Direct Line Telephone Network system of DGON-KWDN section. If required, new system shall be provided for the integration of this section including DGON-KWDN section.

7.3.7.5 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.

7.3.7.6 The assignment of the class of service, priority level and features to any Direct Line Telephone extension shall be configurable.

7.3.8 Direct Line Console

(1) Direct Line Consoles provided under DGON-KWDN system contract for Chief Controller, Deputy Chief Controller, Assistant Controller, Traffic 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 both sections. Direct Line Consoles are to be provided as per Annexure 2.

(2) Network of Main Direct Line Telephone system shall be created using 2 Mbps E1 Channels over SDH Network as covered in Chapter-5 of this Particular Specifications. One E1 link shall be taken from New Sonnagar Link to OCC and one redundant E1 link shall be taken from New Ganjkhwaja to OCC. This E1 connectivity shall cover all DFC stations of this section including DGON-KWDN section. This E1 link will be dedicatedly used for Direct Line Telephone system.

(3) Direct Line Consoles shall be provided for Station Controllers in SCR of DFC Stations and shall have a minimum direct line capacity of 100 lines and shall be capable of interfacing with required direct line extensions.

(4) The Direct Line Console shall be configured as a desktop model/flush mounted in a desk ergonomically matching with the control room furniture.

(5) 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:

(i) originate outgoing calls to the selected user;
(ii) select and answer any incoming calls destined for the Direct Line Telephone Console;
(iii) originate outgoing calls to a pre-defined group of users;
(iv) originate outgoing calls to a group or all users defined by the Direct Line Telephone Console at the time before the call is placed;
(v) make conference calls to add additional users to an established call connection;
(vi) patch calls or put through two individual users for call connection;
(vii) transfer call to PBX extension; and
(viii) make and receive emergency call (override facility).

(6) 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.

(7) 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.

(8) The selection facilities of the Direct Line Console, in the form of physical push button and/or soft key, shall be labeled with identity of the called party or functions of the selection facilities.

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

(10) Dedicated push button and/or soft keys shall be assigned to each telephone line which can be connected to the Direct Line Telephone/Console.

(11) At least 10 spare push buttons and/or soft keys shall be provided for assignment of additional functions or Console/Telephone.

(12) 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.

(13) 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.

(14) The Direct Line Console shall give different audio and visual indication for normal and emergency calls.

7.3.8.1 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.

7.3.8.2 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.

7.3.8.3 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, 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.

(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 DFC stations provided under DGON-KWDN system contract and any other location as required, 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.

7.3.8.4 The Contractor shall set up the priority level for Direct Line Consoles/Telephones in consultation with the Engineer.

7.3.8.5 Direct Line Console shall have preset buttons such that by pressing one of these buttons shall immediately connect to the destination. On the opposite, when a telephone connected to a Direct Line Communication System is picked up, the corresponding button on the Controller's Console shall immediately flash together with the ringing tone.

7.3.9 Voice Recording System

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 DFC Stations. This includes conversation over Direct Line Telephone Network, Control Communication System and Emergency Communication System. Centralised Voice Recording System (VRS) provided at temporary OCC, to record telephone conversations of all controllers and DFC Stations of DGON-KWDN section, shall be upgraded/augmented/reconfigured and shall be shifted to OCC at Allahabad to meet the requirement of this Particular Specifications. If required, new system shall be provided for the integration of the this section including DGON-KWDN.

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 & Phase-2, under Contract Package CP-104/CP-203. Contractor may upgrade/augment/reconfigure this VRS

provided under Contract Package CP-104/CP-203 to meet the requirements of this section including DGON-KWDN section or upgrade/augment/reconfigure existing VRS of DGON-KWDN section to meet the requirement of this section and then integrate with the VRS provided under contract package CP-104/CP-203.

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. Contractor shall upgrade/augment/reconfigure Telephone Network Management System provided under DGON-KWDN system contract at temporary OCC and shift it to OCC at Allahabad to meet the requirements of this Particular Specifications. If required, new system shall be provided for the integration of the this section including DGON-KWDN section.

7.3.10.2 The Telephone Network Management System shall 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 Emergency Communication System

7.3.11.1 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.

7.3.11.2 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.

7.3.11.3 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.

7.3.11.4 Contractor shall upgrade/augment Emergency Control Communication provided under Contract Package CP-104/ CP-203 and DGON-KWDN section to meet the requirements of this Particular Specifications.

7.3.12 Control Communication System

7.3.12.1 Control Communication System shall be provided to meet omnibus voice communication requirement of Train Traffic Control of this section including DGON-KWDN section.

7.3.12.2 This is provided for communication with one-touch button selective calling facility between the Traffic Controller in the OCC and Station Controller at DFC Stations of Mughalsarai-Sonnagar including DGON-KWDN section, 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.

7.3.12.3 Control Communication System shall be provided using Control Communication Equipments as per RDSO Specifications. Control Communication Equipments shall be procured from RDSO approved sources only.

7.3.12.4 Contractor shall upgrade/augment/reconfigure Control Communication System provided under Contract Package CP-104/ CP-203 to meet the requirements of this Particular Specifications. If required, new system shall be provided for the integration of this section including DGON-KWDN section.

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) Telephony Server;
(7) Media Gateway;
(8) Direct Line Consoles;
(9) Direct Line Telephones;
(10) Telephone NMS Workstation;
(11) Control Communication Equipment; and
(12) 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 The Telephone Network Management System shall be considered unavailable if any functions provided by the Telephone Network Management System cannot be properly exercised. The availability of the Telephone Network Management System shall be better than 99.95%.

7.4.3.5 The Voice Mail System shall be considered unavailable under any one or combination of the following conditions:

(i) Message cannot be recorded into the Voice Mail System when the voice mail box of the affected user is not full;
(ii) Message cannot be retrieved by the user; and
(iii) Corruption of voice message stored in the Voice Mail System.

7.4.3.6 The availability of the Voice Mail System shall be better than 99.95%.

7.4.3.7 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.

7.4.3.8 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
2	Wired Ports	256
3	Expandable Ports	256
4	Analogue Telephone Ports	96
5	Digital Telephones Ports	32
6	Ports for CO Lines	4
7	Ports for DID Lines	4

7.5.1.4 If a new PBX is not provided at OCC and PBX provided under DGON-KWDN system contract or under contract package CP-203/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 for this section including DGON-KWDN section. IF PBX system provided under DGON-KWDN system contract is upgraded then it shall be shifted from temporary OCC at Mughalsarai to OCC at Allahabad.

7.5.1.5 The PBX shall be additionally equipped with ports for Direct Line Telephone Network over and above the equipped ports mentioned in Para 7.5.1.3 and 7.5.1.4.

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;

(3) Shall connect long distance subscriber lines upto 10Km on PIJF Telephone Cables.

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 this section including DGON-KWDN section.

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 DGON-KWDN system contract required to meet the requirement of this Particular Specifications.

7.5.2 Voice Mail System (VMS)

7.5.2.1 The VMS shall enable internal and external telephone users to access specific mailboxes using the following peripherals:

(1) analogue telephones using DTMF;
(2) digital telephones;
(3) CO outgoing trunks and DID trunks; and
(4) digital trunk.

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

7.5.2.3 The VMS shall support 300 users for 24 hours a day. The system shall be expandable to 600 users. The ports connecting to the system shall support traffic intensity offered by 300 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.

7.5.2.4 If Contractor upgrade/augment Voice Mail System (VMS) being provided under DGON-KWDN system contract/CP-203/CP-104 to meet the requirements of this Particular Specification, it should be upgraded for 300 Users.

7.5.2.5 Contractor may also install a new VMS for this section and integrate it with existing Voice mail system of DGON-KWDN section, and then Contractor shall upgrade/augment/reconfigure the existing VMS of DGON-KWDN section for above integration so as to have a unified VMS.

7.5.3 Telephone Network Management System

Two 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.

7.6 Block Wiring

7.6.1 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.

7.6.2 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.

7.6.3 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.

7.6.4 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.

7.6.5 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.

7.6.6 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.

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

7.7 Outdoor Telephone Cables

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.

7.8 System Expansion

7.8.1 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.

7.8.2 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.

7.8.3 Wherever the equipment of Telephone System being provided under DGON-KWDN system contract, CP-203 and CP-104 is being upgraded/augmented/reconfigured by Contractor, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

∗End of Chapter 7∗

8. VIDEO SURVEILLANCE SYSTEM REQUIREMENTS

8.1 General

8.1.1 The Video Surveillance Cameras shall be provided for effective real time video surveillance of TSS/RSS at New Durgauti & TSS at New Karwandiya from OCC Allahabad.

8.1.2 Video Surveillance System shall be end to end IP based system with IP Fixed Box Type Video Cameras, Video Management & Recording Servers and LED Backlit Monitors.

8.1.3 Video Surveillance System shall provide on-line display of video images on LED Backlit Monitors located in the Operation Control Theatre in OCC Building Complex. Video Surveillance System shall have Control Equipment located in the Telecommunication Equipment Room (TER) in OCC.

8.1.4 Contractor may upgrade/augment/reconfigure the LED Backlit Monitors, Video Management & Recording Servers, External Storage Device etc. provided under Contract Packages CP-104/CP-203 to meet the requirement of this Particular Specifications.

8.1.5 Whenever existing equipment provided under Contract package CP-104/CP-203 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.

8.2 Scope of Supply

8.2.1 The Scope of Supply for the IP based Video Surveillance System shall include, but not be limited to, the following:

(1) HD Fixed Box Type IP Colour Video Cameras complete with Vari-focal Lenses, Housing and Mounting Arrangement;

(2) 20" Screen Size Full HD LED Backlit Colour Display Unit with PC Workstation for Viewing and Monitoring;

(3) 20" HD LED Backlit Colour Monitors with PC Workstation for Viewing, Monitoring and System Management;

(4) Server Hardware for Video Management and Recording;

(5) RAID -5 External Storage Device;

(6) Layer-2 Switches;

(7) Video Management and Video Recording Software and Perpetual Licenses;

(8) Graphic User Interface Client Software;

(9) Equipment Cabinet, Racks etc as required;

(10) Power and Data Cables, Power Supplies, Cabling and Earthing Accessories including Termination Protection Devices;

(11) Contract Spares; and

(12) Any other equipment's/materials/software as required for completion of the Contract.

8.2.2 Scope of Services

The Contractor shall co-ordinate with Employer to decide location of cameras and other details during design and installation of Video Surveillance System.

8.3 System Requirements

8.3.1 General

8.3.1.1 The Video Surveillance System shall provide monitoring & recording of Colour Video in Real Time.

8.3.1.2 The IP Fixed Video Cameras shall be strategically placed to ensure 100% coverage of Main Entrances Gate, Incoming Bay Area, Outgoing Bay Area, Transformer Area & Power Supply Control Room Building Area of TSS.

8.3.1.3 Each camera shall have a video at HD (High Definition 1280X720p) resolution and 25 FPS (Frames per Second) and a dual stream capability such that viewing and recording at different resolutions and FPS are possible.

8.3.1.4 Traction Power Controller shall be provided one Client PC Workstation with 20" Full HD LED Backlit Colour Monitors for Viewing, Monitoring and System Management. Contractor may upgrade/augment/reconfigure the Client PC Workstation with 20" Full HD LED Backlit Colour Monitors provided for Traction Power Controller at OCC under Contract Packages CP-104 to meet the requirement of this Particular Specifications.

8.3.1.5 Video Surveillance System and Cameras shall offer dual streams of H.264 Video Compression Standards.

8.3.1.6 Display Requirements: The general guideline for displaying the full frame image height of a 1.8m tall person standing upright, within the IP Fixed Video Cameras Coverage Area, on any Monitor shall not be less than one tenth of the screen for both Fixed Lens and Zoom Lens Cameras at the shortest Focal Length. No image degradation shall be caused on the Monitors owing to any external sources of interference including, distortion of the image at the periphery of the screen, rotation of image, mis-convergence of colour image and change of colours on the screen due to changing of external magnetic field level.

8.3.1.7 Video Recording: The Video Recorder shall be capable of operation for 24 hours per day, 365 days a year. The recording shall be preferably stored for at least 30 days at HD Resolution, 12 FPS. The Video Recorder System should, however, be capable of recording at HD Resolution, 25 FPS for all Cameras. The Storage Device for recording shall be with RAID 5 Protection.

8.3.1.8 In the event of recording operation being interrupted, for example by power failure, it shall automatically resume recording, on resumption of power supply, of all the cameras it was recording prior to the interruption.

8.3.1.9 Video Retrieving: It shall be possible for the Traction Power Controller in the OCC to retrieve recorded videos. All recordings shall have the associated time and date stamped information superimposed onto the video image.

8.3.1.10 Contractor shall upgrade/augment/reconfigure the Video Management & Recording Servers, External Storage Device, Data Networking Equipment etc. provided under Contract Packages CP-104 to meet the requirement of this Particular Specifications. If required, new system shall be provided for the integration of this section including DGON-KWDN section

8.4 Performance Requirements

The following performance requirements for the Video Surveillance System shall be complied:

8.4.1 Reliability Requirements

The Contractor shall furnish to the Engineer for the following Sub-Systems/Equipments, the reliability figures i.e. MTBF Hours from the OEMs:

(1) Control and Management Equipment;
(2) Fixed Cameras;
(3) LED Backlit Monitors;
(4) PC Workstation;
(5) Video Recording Equipment;
(6) Switches; and
(7) Other equipment's used in the Video Surveillance System.

8.4.1.1 The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the Specifications shall be considered as a Failure.

8.4.1.2 MTBF shall be the average Operating Time accumulated by the Total Population of Identical Items between failures.

8.4.2 Availability Requirements

8.4.2.1 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 Video Surveillance System shall not be included in the determination of the system availability.

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

(1) failure of LED Backlit Monitor of Traction Power Controller in OCC;

(2) failure of any Switch or Client PC Workstation;
(3) failure of Video Recording Equipment;
(4) all failure conditions leading to the loss of video signal for more than 10% of Video Surveillance System Cameras.

8.4.2.3 The Video Surveillance System shall have an overall availability of better than 99.95%.

8.4.3 Maintainability Requirements

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

8.4.3.2 The service life of the Video Surveillance System (equipment) shall not be less than 15 years. Service life of all types of cables shall not be less than 25 years.

8.4.4 System Safety Requirements

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

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

8.5 Technical requirements

8.5.1 General

8.5.1.1 Proposed Video Surveillance System shall be based on Non Proprietary Open Standard Architecture affording interoperability of hardware, software, OS, networking etc.

8.5.1.2 All control equipment e.g. servers, storage devices etc. shall be Rack mounted. No equipment other than cameras, field switches, cables and their junction boxes shall be installed outside the TER. Switches in outdoor areas should be installed in proper IP 66 vandal proof housing.

8.5.1.3 The internal clock for the Video Surveillance System equipment shall be synchronised to within 1 second of the Master Clock System at all times.

8.5.1.4 All equipment of Video Surveillance System shall work from 180 to 270 V 50 ±3% Hz AC single phase supply from UPS. Appropriate AC Supply Distribution Cubicles/Racks complying to IP54 with 20% spare capacity shall be provided for this. Equipment shall be capable of withstanding ripple of 2%.

8.5.1.5 Power Cable shall be laid from AC Supply Distribution Cubicles/Racks to field equipments of Video Surveillance System for powering them.

8.5.1.6 CAT-6 Cable shall be laid between cameras and field switches. From field switches, optical fibre cable shall be laid to central switch. If distance between a field switch and central switch is less than 90 meters, CAT-6 Cable may also be used. The field switches should have 10/100/1000 SFP Ports for fibre interface for connectivity to central switch. All field switches shall be connected to central switch in star configuration.

8.5.2 Equipment Specific Requirements

8.5.2.1 Fixed Box Type IP Cameras

8.5.2.1.1 Fixed Box Type IP Cameras shall have following technical specifications as a minimum:

1.	Imaging Device	1/3" or 1/4" CMOS Sensor, Progressive Scan.
2.	Active Pixels	1280(H) x 720(V)
3.	Streaming	Dual, individually configurable, H.264 streams.
4.	Frame Rate	25 FPS(Maximum), configurable to 25, 12, 6, 3, 2 & 1 FPS.
5.	Video Resolution	1280X720, Configurable to 1280X720 & 640X360
6.	Video Compression	H.264
7.	Sensitivity • Colour Mode • Night Mode (Black & White)	Scene Illumination (at F1.2, 50 IRE & Shutter Speed 1/50). 0.5 Lux 0.05 Lux

8.	Signal to Noise Ratio	≥50 dB
9.	Shutter Speed	1 to 1/10,000
10.	Data Rate	64 Kbps to 6 Mbps
11.	Lens Mounting	CS
12.	Humidity	20% to 80% non-condensing
13.	Operating Temperature	0 °C to+ 50 °C (with or without housing)
14.	Storage	0 °C to+ 60 °C
15.	Network Connectivity	Ethernet, 10/100 BaseT PoE
16.	PoE	IEEE 802.3af compliant
17.	Automatic Gain Control	Required
18.	Automatic White Balance	Required
19.	Back light Compensation	Required
20.	Network Protocols	As required for Video Surveillance System working.
21.	Vandal-Proof Arrangement	Required for Outdoor Cameras
22.	Web server	Web Server required with embedded Operating System.
23.	Approvals	UL or EN and FCC (for Safety, EMC & Immunity)

8.5.2.1.2 Fixed Box Type IP Video Cameras shall operate on 180 to 270 V AC voltage as required as per the design and implementation.

8.5.2.1.3 Varifocal Lenses with following minimum specifications shall be used for Fixed Box Type IP Video Cameras.

1.	Focal Length	7.5-50 mm
2.	Minimum Object Distance	1 m
3.	Lens Mount	CS-Mount
4.	Iris Control	Auto, DC Control
5.	Focus Control	Manual
6.	Zoom Control	Manual
7.	Operating Temperature	0° C to +50° C
8.	Operating Humidity with camera and housing	20% to 80%, non condensing

8.5.2.1.4 Housing arrangement for Fixed Box Type IP Video Cameras shall be designed for both outdoor and indoor use as per requirement. The Housing shall either be integrated with the camera by the manufacturer or it shall be of same make as the camera. The housing shall protect camera and the lens combination and have the following minimum technical specifications and features:

1.	Windows	3mm (012 inch) glass
2.	Camera Mounting	Removable Camera/Lens Tray, mounted with screws
3.	Construction	Aluminum housing casing, neoprene gaskets, UV resistant polymer end caps.
4.	Tamper-resistance	Tamper-resistant screws for locking clasps shall be provided
5.	Enclosure Protection	IP 66/NEMA-4 or better, with inbuilt heater blower kit
6.	Approvals	UL or EN and FCC (for Safety, EMC & Immunity)
7.	Vandal Proof Arrangement	Required for Outdoor Cameras.

8.5.2.1.5 Mount for the Camera

Mounts shall be suitable for indoor and outdoor mounting units and designed for fixed cameras or camera housing installations. Mount shall have the following features:

(1) Feed-through design for cable management;
(2) 360^{o} rotation and 180^{o} tilt;
(3) Versatile design;
(4) Adjustable mount heads;
(5) Corrosion-resistant finish.

8.5.2.2 20" HD LED Backlit Colour Monitors:

8.5.2.2.1 LED Backlit Colour Monitors shall be used in conjunction with PC Workstations for Viewing, Monitoring and System Management.

8.5.2.2.2 LED Backlit Colour Monitors shall have following minimum specifications:

1.	Viewable Display Area	20″ when measured diagonally on the screen
2.	Resolution	HD 1280 X 720
3.	Contrast Ratio	500:1
4.	Video I/P	S-Video, Video/Composite Video, PC Analogue Input (RGB, D-Sub), HDMI, SVGA, VGA
5.	Display Control	Monitor control on screen display, programmable with front panel.

8.5.2.3 PC Workstation

8.5.2.3.1 PC Workstation shall be used with 20" HD LED Backlit Colour Monitors for System Management & General Monitoring.

8.5.2.3.2 The PC Workstations for Viewing, Monitoring and System Management shall be able to provide High Quality Graphics Display.

8.5.2.3.3 PC Workstation shall also consist of following minimum items:

(1) HDD Interface SAS/SATA/IDE or better, RAM 4 GB upgradable up to 24 GB, OS - Windows XP Professional/ Linux or latest.

(2) 256MB Dual DVI Graphic Card: NVIDIA NVS 295 or better.

(3) PC Workstation should have minimum 5 PCI slots (preferably 1 PCI Express Gen 2x16 slot, 1 PCI Express Gen 1 x4 - with x8 connector, 1 PCI express Gen 2 x4 with x8 connector, 2 legacy PCI 32 bit/33 MHz).

8.5.2.4 Server Hardware for Video Management and Recording:

8.5.2.4.1 Server for Video Management & Recording shall be 19" rack mountable, dual Intel quad core Xeon 5520 or better processor, 2.26 GHz or better chipset, Intel High Performance 5520 Chipset Intel Quick Path Interconnect (QPI) @ maximum 5.86GT/S or better. All servers for Video Management & Recording in the OCC shall be provided with back up.

8.5.2.4.2 Server hardware for Video Management & Recording shall have the minimum following specifications:

(i)	HDD Interface	6 x 2.5" Hot plug SAS or better, Memory 6 GB ECC DDR3 SDRAM expandable upto 144 GB, OS Microsoft Windows Server 2003 Standard Edition or higher with 5 Client licenses or Linux.
(ii)	CD Drive	DVD ROM Drive
(iii)	Ethernet Card	Quad Onboard/ on slot Gigabit Ethernet with Load Balancing and Fait over Support. Remote management card with IPv6 compliance.
(iv)	Other Features	Onboard SAS Controller and SAS RAID controller for external connectivity with minimum 512 MB cache Hot-plug HDD, redundant Hot-plug power supply. 2 internal Hot-plug SCSI HDD. 1 or 2 U mounting.
(v)	HDD	146 GB x 2 RAID 1 SAS HDD, 10,000 RPM

8.5.2.4.3 Suitable database licenses should be provided as required by the solution offered by the vendor.

8.5.2.4.4 Server Hardware for Video Management System provided under CP-104 may be upgraded/augmented/reconfigured by Contractor to meet the requirements of this Particular Specifications.

8.5.2.5 Storage Device with RAID 5 Protection:

8.5.2.5.1 A protected storage device shall be provided for recording the information at OCC.

8.5.2.5.2 The storage system should have at least 4 interfaces of FC or iSCSI across dual redundant controllers, 4 GB protected Cache (battery backed or equivalent), scalability up to minimum 120 TB raw, redundant power supplies & fans. FC HBA card should be provided in host server for connectivity in case system is provided with FC interface.

8.5.2.5.3 The storage device should support simultaneous play back and recording at full duplex operation. It should possess the capability of carrying SAS and SATA and should be accessible to the connected server.

8.5.2.5.4 The system should provide minimum 18.0 TB usable after RAID 5 configuration for every 32 cameras for storing minimum 30 days recording.

8.5.2.5.5 LED/LCD indicators shall be available for system status, power supply, fan fault, hard drives and carrier, enclosure management module.

8.5.2.5.6 RAID Configurations:

(1) RAID levels 5
(2) Maximum 256 virtual drives
(3) It should provide at least one hot spare disk

8.5.2.5.7 External Storage Device with RAID Protection provided under CP-104 shall be upgraded/augmented/reconfigured by Contractor to meet the requirements of this Particular Specification.

8.5.2.6 Layer-2 Switches for Field:

8.5.2.6.1 8 Port Layer-2 Switches are to be provided for field applications. These switches should have one 10/100/1000 SFP Port (fibre port) and 7 fast Ethernet Ports with RJ 45 Connectors, complying with IEEE 802.3, IEEE 803.3u and 802.3ab standard. These Layer-2 Switches should also be PoE compliant as per IEEE 802.3af.

8.5.2.6.2 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.

8.5.2.6.3 All Software/Hardware/License supplied along with the Layer-2 Switches shall be supplied to the Engineer.

8.5.2.6.4 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).

8.5.2.6.5 Layer-2 Switches shall have console port with a RS-232 Interface for configuration and diagnostics purposes.

8.5.2.6.6 Ethernet output from the IP camera shall be connected to the nearest field switch through CAT 6 STP cable and the field switch shall be connected to the central switch on optical fibre cable/CAT6 STP cable.

8.5.2.6.7 Required numbers of Small Form-factor Pluggable (SFP) modules, compact optical transceivers used in optical communications, should be supplied along with each switch. SFP modules should comply with Multi-Source Agreement (MSA), enabling the compatibility with other vendors' equipment.

8.6 Software Requirements

8.6.1 Video Management Software

8.6.1.1 This shall be a highly scalable enterprise level software solution. It shall offer a complete video surveillance solution that will be scalable to required numbers of cameras that can be added on a unit-by-unit basis.

8.6.1.2 The video management software shall operate on open architecture and should require no proprietary hardware.

8.6.1.3 The user with administrative rights shall create clients (users) and give access to the software client application based on predefined user access rights.

8.6.1.4 The system shall allow the recording, live monitoring, playback of archived video and data simultaneously.

8.6.1.5 The software shall provide the following

(1) Several simultaneous live picture connections of camera in network.
(2) Configuration of monitoring situation (site maps and workspace).
(3) Programming of alarm-triggered automatic events in various alarms configuration.
(4) System set up with limited operation options for clearly defined surveillance tasks.
(5) Programming of automatic recording events on a network recorder.

8.6.1.6 The software shall allow display of dual H.264 video streams in real time simultaneously at different frame rates and different resolution.

8.6.1.7 Each camera's bit rate, frame rate and resolution shall be set independently from other cameras in the system, and altering these settings shall not affect the recording and display settings of other cameras.

8.6.1.8 The software shall provide automatic search and registration of components of video surveillance system on the network which can be cameras, monitors, alarm panels etc.

8.6.1.9 The software shall provide drag & drop functions on the system and also for set up of connection between cameras and monitors.

8.6.1.10 The software shall allow the following:

(1) Live display of cameras.
(2) Live display of camera sequences
(3) Playback of archived video
(4) Retrieval of archived video
(5) Instant Replay of live video
(6) Use of site maps
(7) Use of Macros
(8) Configuration of system settings.

8.6.1.11 The software should be able to do video recording on any of the options viz. inbuilt hard disks on the server, direct attached storage boxes attached to servers, network attached storage, storage area network.

8.6.1.12 The software should be capable of handling camera and alarm icons on area maps. The area map should be configurable to pop up upon the receipt of an alarm received from a camera on the map. This can be on the same or other monitors on the PC.

8.6.1.13 The software shall be able to select the required recording based on the time recording was activated, the duration of recording, operator activated recording, event activated recording, scheduled recording.

8.6.1.14 The software shall offer a plug and play type hardware discovery service with the function of automatically discover devices as they are attached to the network.

8.6.1.15 The software shall provide a reporting utility for tracking for the following minimum options, Video and images shall be stored with reports for documenting events.

(1) Alarms
(2) Incidents
(3) Operator logs

8.6.1.16 The software shall have the facility to export the desired portion of clipping of video from a desired date/time to another desired date/time on DVD or on any Client/Network Storage Device. Viewing of this recording shall be possible on authorized player which shall be provided by software manufacturer or in media player on computer utilizing Window environment.

8.6.1.17 The software database servers shall not limit the number of Video Recording Servers which can be networked together to form Video Management and Recording System.

8.6.1.18 The software database server shall maintain a catalog of settings for all the clients, servers, and cameras in the system. If database management & recording cannot be managed by single server, in such cases, additional server should be provided.

8.6.1.19 The software shall enable the client to dynamically create connections between cameras and clients and view live or recorded video on the digital VGA monitors (video, serial ports and digital l/Os).

8.6.1.20 The software shall provide the client seamless operation of all cameras and clients available in the system regardless of the actual connection to different Network Video Recording servers.

8.6.1.21 The software shall detect signal loss, low signal to noise ratio etc. and have the capability to alert the systems administrator.

8.6.1.22 The software shall create an audit trail of all events and user activities.

8.6.1.23 The software shall support a built-in Virtual Video Matrix Switcher to provide a full matrix operation of IP Video to Digital Monitors. The Virtual Matrix Switch shall have the capability of creating camera sequences with the following functionalities:

(1) Each Sequence shall have capability up to hundreds of cameras.
(2) Each camera in the sequence shall have its own individual dwell time, from 1 to 60 seconds.
(3) Multiple users shall be able to view the same camera sequence simultaneously, not necessarily synchronized one with the other.

8.6.1.24 The software shall provide Alarm Management Module to set any monitor or groups of monitors to automatically display cameras in response to alarm inputs.

8.6.1.25 It shall be possible to search for recordings in the software by camera, date and time. If a data and time is specified, playback shall commence from that date and time. It shall be possible to playback more than one camera simultaneously.

8.6.1.26 The software should support at least 64 video streams concurrently. It should support at least 4 monitors in one server/ workstation for displaying live video. It should allow minimum 5 levels of user and alarm prioritization, It should allow minimum 16 cameras to be replayed simultaneously.

8.6.1.27 Video Management Software provided under CP-104 may be upgraded by Contractor to meet the requirements of this Particular Specification. If required, new system shall be provided for the integration of this section including DGON-KWDN section.

8.6.2 Video Recording Software

8.6.2.1 Software shall support recording of H.264 video streams. It shall support recording of video and audio for all the channels.

8.6.2.2 Software shall support triplex applications, recording, re-play and backup simultaneously. It shall be compatible with windows Server OS or Linux for highest performance and reliability.

8.6.2.3 Software shall operate on open architecture and should not require any proprietary hardware.

8.6.2.4 Software shall be able to record minimum 32 different video streams or more simultaneously. It shall be accessible from any PC connected to the network.

8.6.2.5 Software shall provide network time server function to ensure the synchronization of the video servers and the recordings.

8.6.2.6 The servers shall be connected to the network so that these can be placed at any location which has network access.

8.6.2.7 The software should be able to receive alarms of different types from equipment to start a recording.

8.6.2.8 The software alarm recording shall support pre-and post-alarm periods. Both can be configured in duration.

8.6.2.9 The software should provide a status of the available recording capacity, as well as an indication of the remaining possible recording time.

8.6.2.10 Video Recording Software provided under CP-104 may be upgraded by Contractor to meet the requirements of this Particular Specification.

8.6.2.11 Fault Tolerant Recording

8.6.2.11.1 If software & server(s) operation are interrupted, like power disconnection and once the server(s) are restarted, these shall automatically resume recording of any cameras that were being recorded prior to the interruption.

8.6.2.11.2 The software shall support network fault-tolerant recording such that if the network connection between a video management server and video recording server becomes unavailable, for example through cable breakage, network congestion or WAN interruption, the system operation shall automatically recover when the connection is restored.

8.6.2.12 Search & Export

8.6.2.12.1 It shall be possible to search for recordings in the software by camera, date and time. If a data and time is specified, playback shall commence from that date and time. It shall be possible to playback more than one camera simultaneously.

8.6.2.12.2 The software shall be able to export sections of recordings to a separate Windows folder, which can then be written to CD-ROM, DVD-ROM or tape media to be played back at a location not connected to the network video management & recording network. The export process should make available a player application, which can be provided with the exported video. Export should be possible in Windows media player compatible format. Simultaneous export of multiple cameras should also be possible.

8.6.3 GUI (Graphic User Interface)

8.6.3.1 The GUI Software shall perform the following applications simultaneously without interfering with any of the storage server operations :

(1) Live display of cameras.
(2) Live display of camera sequences.
(3) Playback of archived video.
(4) Retrieval of archived video.
(5) Instant replay of live video.
(6) Use of graphical controls (maps).

8.6.3.2 The GUI Software shall provide an authentication mechanism, which verifies the validity of the user.

8.6.3.3 The GUI Software shall provide management and control over the Video Surveillance System using a standard PC Mouse and Keyboard.

8.6.3.4 The GUI Software shall support display, video of cameras, on 20" LED Display Unit or on 20” Monitors. The operator from the GUI Software shall be able to decide the cameras that shall be displayed on the Display Unit/Monitors.

8.6.3.5 The GUI Software shall enable view of 1 to 16 video tiles simultaneously on a single Display Unit/Monitor at 25 FPS per camera. It shall support display of tile views of Full Screen or Quad or 3X3 or 4X4 or 1+5 or 1+9 or 1+11 or 1+15 on each of the Display Unit/Monitor independently.

8.6.3.6 The GUI Software shall allow operators to view an instant replay of any camera. The operator shall be able to define the amount of time he wishes to go back from a predefine list or through a custom setup period. The operator shall be able to control the playback with play, pause, forward, and speed buttons.

8.6.3.7 The operator shall be able to choose and trigger following minimum action from site map:

(1) View camera in a Video Tile.
(2) View map or procedure in a Video Tile.

8.6.3.8 The GUI Software shall display all cameras attached to the Video Surveillance System regardless of their physical location on the network.

8.6.3.9 The GUI Software shall display all camera sequences created in the system. It shall allow operators to control (pause/play, skip forwards, skip backwards) camera sequences, without affecting other operators' ability to view and control the same sequence.

8.6.3.10 The GUI Software shall display all cameras, sequences and users in a logical tree. The GUI Software operator shall be able to drag and drop a camera or camera sequence from a tree of cameras into any video tile for live viewing.

8.6.3.11 The GUI Software shall support graphical site representation (map) functionality, where digital maps are used to represent the physical location of cameras throughout facility. The maps shall have the ability to contain hyperlinks to create a hierarchy of interlinked maps.

8.6.3.12 The operator shall be able to drag and drop a camera from a map into a video tile for live viewing in the same browser without opening a new browser.

8.6.3.13 The GUI software shall support Digital Zoom on a Fixed camera's live video streams.

8.7 System Expansion

8.7.2 Video Surveillance System equipment shall as a minimum be modularly expandable to an expansion capacity of 50% by the addition of cards and/or modules without the need to replace the installed hardware and software of the system.

8.7.3 Wherever the equipment of Video Surveillance System being provided under contract package CP-104/CP-203 is being upgraded/augmented/reconfigured, this upgradation/augmentation/reconfiguration shall not in any way utilize available provision of expansion.

End of Chapter 8

9. MASTER CLOCK SYSTEM REQUIREMENTS

9.1 General

9.1.1 The Master Clock System shall provide synchronized time information for this Project. Global Positioning System (GPS) shall be the time source for this Master Clock System.

9.1.2 The time source shall be used to synchronize slave clock units which shall be located throughout the EDFC areas such as offices, control rooms, etc. for staff information.

9.1.3 The synchronized time information shall be provided to other interfacing systems via the OFC System. Synchronization of the time information of other systems shall be achieved by means of the Network Time Protocol (NTP)

9.1.4 Contractor shall upgrade The Master Clock System provided under DGON-KWDN system contract at Temporary OCC at Mughalsarai and shift the same to OCC at Allahabad or upgrade /augment/reconfigure the system provided under Contract Package CP-203 /CP-104 to meet the requirements of this Particular Specification. If required, new system shall be provided for the integration of this section including DGON-KWDN section at OCC.

9.1.5 Whenever existing equipment of Master Clock System being provided under DGON-KWDN system contract is 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.

9.2 Scope of Supply for Master Clock System

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

1) Central Master Clock System;
2) GPS Receiver and Antenna;
3) Master Clock control and distribution equipment;
4) Sub-master clocks;
5) Slave Clocks (analogue and digital clock display units);
6) Power supply cables, earthing and accessories including termination and protection devices;
7) Installation, testing and commissioning materials;
8) 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 Coordinated’ (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 as decided by Engineer shall receive the time source via 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 using NTP by an Ethernet interface to the Optical Fibre Communication System.

9.3.4 At New ERC Mughalsarai, New GanjKhwaja, New Sonnagar Link, New Sonnagar, New Chiraillapathu, IMD/IMSD, and OCC, 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. Clock Schedule is shown in Annexure-3.

9.3.6 The Slave Clocks shall be of analogue or digital types. The engineering shall ensure that these clock units shall provide good visibility.

9.3.7 Each of the systems that require synchronized time information shall be connected to the OCC or Station LAN's and obtain the information using the NTP, as the common time source distributed throughout EDFC.

9.3.8 Central Master Clock provided under system contract DGON-KWDN/CP-104/CP-203 may be upgraded/augmented/reconfigured by Contractor to meet the requirements of this Particular Specification. If required, new system shall be provided for the integration of this section including DGON-KWDN section at OCC.

9.4 Performance Specifications

9.4.1 General

9.4.1.1 In addition to what has been specified in Chapter 3, the following performance requirements for the master clock system shall be complied.

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

9.4.2 Reliability

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

9.4.2.2 Contractor shall furnish to the Engineer the reliability figures i.e. MTBF Hours from the OEMs of the following sub-systems/equipment:

(1) Master Clock;
(2) Sub-Master Clock; and
(3) GPS Receiver.

9.4.3 Availability Requirements

9.4.3.1 The contractor shall implement a RAMS Plan defined in accordance with IEC 62278. Contractor shall submit to the Engineer for review the RAMS analysis for the Master Clock System to establish the requirements of availability specified herein below.

9.4.3.2 The Master Clock System shall be considered unavailable if the clock signal is not available at any location or the accuracy of the clock signal is below the specification. The availability of the master clock equipment shall be better than 99.99%.

9.4.4 Maintainability Requirements

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

9.4.4.2 The service life of the Master Clock System shall not be less than 15 years.

9.4.5 System Safety Requirements

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

9.4.5.2 All metallic enclosures shall be provided with an earth terminal

9.4.5.3 The free run accuracy of the Master Clock Units shall never be more than 30 milliseconds different from the GPS reference for duration of 24 hours of loss of time synchronization with GPS.

9.4.5.4 Network time synchronization over the data network shall be using NTP, with an accuracy of ±0.01 s per 24 hours to the reference.

9.4.5.5 The Sub-Master Clocks shall have a minimum accuracy of 1s a day when they do not receive signals from the Master Clock.

9.5 Technical Requirements

9.5.1 Antenna System

(1) Surge protector shall be provided to shunt potentially damaging voltages on antenna coaxial to ground.
(2) The system shall be weatherproof. It shall be tolerant to direct sunlight, wind, rain and other sources of water.
(3) The antenna shall be mounted at appropriate location to be identified during detail design. Surge Protector shall be provided between Antenna and Central Master Clock Units.

9.5.2 Central Master Clock System

(1) The Central Master Clock Unit 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.
(2) 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.
(3) 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.
(4) The Master Clock Unit shall have its own oscillator and be able to maintain accurate time for normal duration of loss of time synchronization signal. The system shall be able to detect the absence or abnormality of the GPS time signals. The system shall be self-correcting in the event the synchronization from the GPS is lost and re-established.
(5) The Master Clock Unit shall support connectivity of Ethernet TCP/IP network, RS485 and RS232.
(6) The Master Clock Unit shall include Network Time Server to provide NTP timing for other interfacing systems connected to the OCC, DFC Stations, IMD/IMSD on LAN. The type and quantities of the clock output interfaces shall be determined by the interface requirements of the subsystems and relevant interfacing project contractors.
(7) Outages of power supply of normal duration to the system shall have no significant impact on the accuracy of the system time.
(8) Audio and visual alarm outputs shall be provided to indicate loss of time synchronization or power.
(9) The status of the Master Clock System including GPS Receiving System, Master Clock Unit, Clock Distribution System, Sub Master Clocks and the NTP Servers shall be monitored by the OFC Communication NMS or a dedicated Clock Management System.

(10) The Clock Management System shall provide full configuration support for Master Clock units and Sub Master Clocks.

9.5.3 Sub Master Clock

(1) The Sub-Master Clock at Stations etc. shall be synchronized by the central Master Clock Unit over NTP.

(2) The Sub Master Clocks shall have its own internal clock and be able to maintain accurate time for normal duration of loss of time synchronization signal. The system shall be able to detect the absence or abnormality of the synchronized time signal from the central master clock system. On restoration of the Master Clock signal the Sub Master Clock shall validate the signal and after successful validation the Sub Master Clock shall self correct if necessary.

(3) Local display of the time shall be provided. Display shall include hours, minutes.

9.5.4 Display Clocks

(1) All display clocks shall be synchronized by the Central/Station Sub Master Clocks.
(2) Analog Slave Clocks for indoor use shall be with minimum dial diameter of 30 cm, with minimum viewing distance of 30 meter.
(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.
(4) The displayed time of all display clocks shall be hours and minutes.
(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.
(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.
(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.
(8) The Slave Clocks shall be manufactured to be used in non-air-conditioned environment with high humidity exposure.

9.5.5 The Master Clock System shall be capable of working from 230 volts +/- 20% AC 50 Hz supply.

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 20 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.

End of Chapter 9

10. VHF COMMUNICATION SYSTEM

10.1 25 Watt VHF Transceivers

10.1.1 VHF Communication System shall be created at DFC Stations using 25 Watt VHF Transceivers. 25 Watt VHF Transceivers shall be installed in Station Control Room and any other specified place as decided by 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.

10.1.2 48 volt DC Power Supply from Battery Charger shall be used as a Power Source for these 25 Watt VHF Transceivers.

10.1.3 Quantity of 25 Watt VHF Transceivers along with Power Supply, Pole/Mast, Antenna, Associated Accessories & Cables are given in Annexure-6.

10.1.4 Specification of 25 Watt VHF Transceivers are as given below:

General		
1.	Frequency Range	136-174 MHz (Full Band)
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz
4.	Frequency spread	5 MHZ or more without degradation in Tx/Rx specifications
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	11 KOF3
7.	Type of Operation	Simplex, press to talk with built in condenser mic and speaker
8.	Type of Antenna	Omni directional antenna complete with cable and other accessories.
9.	Speaker Impedance	To be specified by the firms at internal External speaker point.
10.	Speaker	Internal Speaker as well as Socket for External Speaker to be provided (The Internal Speaker should be cut-off when External Speaker is used).
11.	Output Impedance	50 Ohms and the Aerial Terminal should have VHF Female Socket.
12	Protection	(i) Reverse Polarity protection should be provided. (ii)The final transistor should be protected against high VSWR
Transmitter		
1.	RF Power output	25W +/- 0.5 dB
2.	Frequency Deviation	+- 2.5 KHz Max. (For 100% at 1 KHz) for 12.5 KHz channel spacing.
3.	Modulation Sensitivity	1 to 10mV at 1 KHz at mic input for +- 1.5 KHz (for 12.5 KHz channel spacing) standard deviation
4.	Modulation Distortion	Less than 5% at 1 KHz reference +/-1.5 KHz (for 12.5 KHz channel spacing) Standard deviation.
5.	Modulation Fidelity	+1, -3 db of 6 dB/Octave pre-emphasis characteristics from 300 Hz to 2700 Hz.

		With 1 KHz as reference.
6.	Spurious & Harmonics supersession	Better than 60 dB
Receiver		
1.	Sensitivity	0.30 micro V for 12 dB SINAD
3.	Squelch Sensitivity	0.25 micro V or better at threshold.
4.	Selectivity	Better than 60 dB
5.	Image Rejection	Better than 65 dB
6.	Audio Output	1W with less than 5% distortion at 1 KHz reference measured at specified audio Output.
7.	Audio Response	+1, -3 dB or 6dB/ Octave de-emphasis Characteristics from 300 Hz to 2700 Ha. With 1 KHz s reference.
Feature-wise Configurations		
1.	Simple press to talk	
2.	Protection against high VSWR	
3.	Channel spacing (12.5KHz)	
4.	PTT ID Encode	
5.	CTCSS/DCS	
6.	Busy Channel Lockout	
7.	Channel scanning with call quieting facility	
8.	2 Tone/DTMF/5-Tone Signalling	
9.	Selective Call Decode.	
10.	Capable of being killed/Unkilled	

10.2 5 Watt VHF Walkie-Talkie Sets

10.2.1 All 5 Watt VHF Walkie-Talkie Sets shall be supplied complete with their standard OEM Battery Packs, Antenna and Charger.

10.2.2 Quantity of 5 Watt VHF Walkie-Talkie Sets along with Battery, Battery Charger are given in Annexure-6.

10.2.3 Specification of 5 Watt VHF Walkie-Talkie Sets are as given below:

General		
1.	Frequency Range	136-174 MHz (Full Band)
2.	No. of Channels	16 Channels or more
3.	Channel Spacing	12.5 KHz
4.	Frequency spread	5 MHZ or more without degradation in Tx/Rx specifications
5.	Frequency Stability	5 PPM or better
6.	Type of Emission	11 KOF3
7.	Type of Operation	Simplex, press to talk with built in condenser mic and speaker
8.	Type of Antenna	Helical Antenna suitable for Frequency Range specified.
9.	Speaker Impedance	To be specified by the firms at internal external speaker point.

10.	Speaker	Internal Speaker as well as Socket for External Speaker to be provided (The Internal Speaker should be cut-off when External Speaker is used).
11.	Output Impedance	50 Ohms and the Aerial Terminal should have VHF Female Socket.
12	Protection	(i) Reverse Polarity protection should be provided. (ii) The final transistor should 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	25W +/- 0.5 dB1W/5W+/- 0.5dB switch able/ programmable
2.	Frequency Deviation	+/- 2.5 KHz Max. (For 100% at 1 KHz) for 12.5 KHz channel spacing.
3.	Modulation Sensitivity	1 to 10mV at 1 KHz at mic input for +/- 1.5 KHz (for 12.5 KHz channel spacing) standard deviation
4.	Modulation Distortion	Less than 5% at 1 KHz reference +/-1.5 KHz (for 12.5 KHz channel spacing) Standard deviation.
5.	Modulation Fidelity	+1, -3 db of 6 dB/Octave pre-emphasis characteristics from 300 Hz to 2700 Hz. With 1 KHz as reference.
6.	Spurious & Harmonics supersession	Better than 60 dB
7.	VSWR	Better than 1.5
Receiver		
1.	Sensitivity	0.30 micro V for 12 dB SINAD
3.	Squelch Sensitivity	0.25 micro V or better at threshold.
4.	Selectivity	Better than 60 dB
5.	Image Rejection	Better than 65 dB
6.	Audio Output	250mW/500mW with less than 5% distortion at 1 KHz reference measured at specified AF output.
7.	Audio Response	+1, -3 dB or 6dB/ Octave de-emphasis characteristics from 300 Hz to 2700 Hz. With 1 KHz as reference.
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	
7.	Busy Channel Lockout	
8.	Channel Scanning with Call Quieting facility	
9.	2 Tone/DTMF/5-Tone Signalling	
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 : -10 deg. C to +55 Deg. C

Storage Temperature Range : -40 deg. C to +70 deg C

Relative Humidity : 95% Max +40 deg C non condensing.

10.3.2 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 Definitive Design for review of Engineer. Environmental Test Reports for environment test sequence as under at a specified laboratory shall cover following tests:

SN	Test	Test to be conducted conditions of test to ISO-9000	
a)	Dry Test	Part-III/SEC.5/1977	55 Degree C(+/-) 2 Degree C.RH < 50% Duration 16 Hr.
b)	Dump Heat (Cyclic) Test	Part-V/SEC.2/Variant1/1981	40 degree C(+/-) 2 Degree C, RH 95%. Two cycles of 24 (12+12) hrs.each.
c)	Cold Test	Part-II/SEC. 4/1977	(-)10 degree C +/-3 Degree 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 with 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	- 40 degree C for 5 hours. Then raise the temperature to 70 degree C for 16 hrs.
g)	Bump test	Part VII/SEC.2/1979	4000 bumps at peak Acceleration of 400m/s.sq.

(i) Environmental Test Report with equivalent or superior conditions would be acceptable.

(ii) In the 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 should not degrade by more than 1 dB
2. Receiver Sensitivity : It should not degrade by more than 1 dB
3. Frequency Stability : No degradation shall be noticed on any frequency within the specified Range

(iii) 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 when measured at C/5 rate	:	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

11. 48 V DC BATTERY BACKUP SYSTEM REQUIREMENTS

11.1 General

11.1.1 The 48 V DC Battery Backup System for each TER and CER, shall be sized to power its full load including (but not limited) to Telephone System and OFC System.

11.1.2 For high availability the 48 V DC Battery Backup System at each location shall include 2 numbers of SMPS based 48 V Battery Chargers in redundant configuration with individual 48 V Battery Banks for each Battery Charger.

11.1.3 230 V AC Power Supply for 48 V DC Battery Backup System shall be provided as detailed in Particular Specification (Signaling System).

11.1.4 The Battery shall consist of VRLA (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, Station, Auto Signal Location, LC Gate Location, etc.).

11.3 Technical Requirements

11.3.1 Each of the two Battery Banks shall provide busy hour reserve of four (4) hours for all equipment installed in TER and CER at OCC, Station, Auto Signal Location, LC Gate Location, etc.

11.3.2 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 and usage shall be considered. In addition spare capacity of 25% shall be provided to cater for any requirement of additional equipment at that location.

11.3.3 Battery Charger Capacity shall be determined as Load Current+Battery Capacity*10.

11.3.4 Battery Chargers shall be as per RDSO Specifications RDSO/SPN/TC/23/99 Version 4.0 with Latest Amendments. Each Charger system shall be sized to power full load of OFC System, radio system(If Applicable), Telephone System 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.

11.3.5 The Battery Backup System shall include Line Protecting Devices, Battery Chargers, Battery Banks and Changeover Logic System for change over from Battery Bank 1 to Battery Bank 2 and vice versa and Load Distribution arrangement.

11.3.6 The design shall ensure that the failure of a single component does not cause failure of the Backup system.

11.3.7 All Battery Cells shall be of the Sealed Maintenance Free Valve Regulated Lead Acid type to RDSO specifications IRS S93-96 with Latest Amendments for capacities up to and including 500 AH and to DOT specifications No.TQ.510G 92 with Latest Amendments for capacities beyond 500 AH. VRLA Battery Cells shall be procured only from RDSO Approved Sources for RDSO approved capacities up to & including

500 AH and from DOT approved sources, for capacities beyond. The Service Life of the VRLA Battery Cells shall not be less than 10 Years.

11.3.8 There shall be no break in the 48 V DC Power Supply to the Telecommunication Systems during changeover from the Working to standby Battery Bank.

11.3.9 The following data shall apply to 48 V DC Battery Backup System:

(1)	Input Voltage Range (Single phase)	: 240 V AC (+10 %, - 20%)
(2)	Input frequency	: 50 Hz +/- 5%
(3)	Output Current	: As required for each location

11.3.10 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

11.3.11 System control functions shall include:

(1) Float/ charge mode facility
(2) Auto/Manual Switch for boost charging.

11.3.12 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

11.3.13 Alarms for the Battery Backup System shall be implemented through OFC System NMS in the CER at OCC using appropriate interface such as RS-232, TCP/IP etc. Following alarms shall be provided on the NMS of OFC System at OCC for each of the two SMPS Battery chargers & Battery Banks at all locations.

(1) Mains Fail
(2) Operation OK
(3) Input Voltage High
(4) Over Load
(5) Boost Mode
(6) Float Mode
(7) Rectifier Modules Fail (one or more than one)
(8) Mains Low
(9) Battery Cut-Off Pre-Alarm
(10) Over temperature
(11) Summary Alarm

11.3.14 In case dedicated NMS for the Battery Backup System is provided, it shall be implemented with 21" TFT Based MMI and kept in the CER at OCC.

11.4 System Expansion

The Battery Backup system shall be designed and equipped with all necessary hardware, software and capacity for future 25 % Additional Load. All the components like Transformers, Batteries, Cables etc. shall as a minimum cater to 25% Spare Capacity.

End of Chapter 11

12. INTERFACES

12.1 The Telecom Systems shall be required to interface with various Systems/Contractors for following items at least but not limited.

12.2 It will be the responsibility of the Contractor that interface requirements be finalised as early as possible. Contractual delays and consequential implications as a result of delay in such co-ordination on account of reasons attributable to the Contractor, as concluded by the Engineer, shall be the sole responsibility of the Contractor.

12.3 It would be the responsibility of the Contractor to settle all disagreements with the Designated Contractors. 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.

12.4 An Interface Management Plan shall be prepared and submitted to the Engineer for review.

12.5 Contractor shall develop Interface Specification for interface requirements between Telecom Systems and other Systems to be provided under this contract and submit to Engineer for review. Some of the interface requirements, but not limited to, are listed hereunder:

Interface System	Interface Requirements	Document or Drawing
Electrical/Traction Systems	Earthing System for Telecom Systems.	Interface specification as reviewed by Engineer.
	Power Distribution Interface at OCC/Station/Block Section.	Interface specification incorporating requirement of Electric Load as reviewed by Engineer.
	EMC/EMI Management	Interface Specification as reviewed by Engineer.
	Light, Fan, Switch, Socket, Temperature-Regulation &, Air-Circulation requirement at TER at Stations/OCC.	Interface specification as reviewed by Engineer. Requirement of these items for Telecom Systems shall be included in Interface specification.
	Light, Fan, Switch, Socket Temperature-Regulation &, Air-Circulation requirement at Telecom Power Supply Room at Stations/OCC.	Interface specification as reviewed by Engineer. Requirement of these items for Telecom Systems shall be included in Interface specification.
	Safeguard of Telecom Cables at Power Line Crossing.	Interface Specification as reviewed by Engineer.
	Telecom System Requirement for Traction Power SCADA such as Communication Channel/ Bandwidth.	Interface Specification as reviewed by Engineer.
Signalling System	Telecom System requirement for Signalling System	Interface Specification as reviewed by Engineer.

12.6 The Contractor shall coordinate with the other designated Civil/Track Contractors and submit the Telecom System requirements along with details to them. Some of interface requirements, but not limited to, are listed hereunder:

Interface Contractor	Interface Requirements	Document or Drawing
Civil/Track/ Contractors	Space for trenching on track side for laying of Telecom Cables.	Telecom Cable Route Plan as reviewed by Engineer.
	Provision of Telecom Equipment Room at Stations	TER Drawing showing Requirement of Flooring, False Ceiling, Cable Duct etc. as reviewed by Engineer.
	Provision of Telecom Power Supply Equipment Room at Stations	Telecom Power Supply Equipment Room Drawing showing requirement of Flooring, False Ceiling, Cable Duct etc. as reviewed by Engineer.
	Space for provision of Telecom System in Station Controller's Office.	Telecom Equipment Layout in Station Controller's Office as reviewed by Engineer.
	Space for auto Location Huts in Block Sections & LC Gate Goomtys.	Location drawings with dimensions as reviewed by Engineer.
	Cable Duct requirements in PSC type bridges.	Cable Duct requirements as Reviewed by Engineer.
	Locations for Track/Road/Platform Crossing for Telecom Cables	Location for Track/Road/Platform Crossing as reviewed by Engineer.

12.7 The contractors shall co-ordinate for ensuring the minimum safe distance between any Telecommunication field installation and the live OHE contact point of ''25kV AC Conventional System''/''25 kV AT Feeder System'' for the purpose of human safety apart from EMI/ EMC considerations.

12.8 Interface between Telecom & SCADA Systems shall be implemented on MDF/DDF/ODF in an interface cabinet in the Telecom Equipment Room either at Stations/Block Section or at TSS/SP/SSP.

12.9 Surge Protection Devices shall be provided on each channel both at Telecom Equipment Sides and Traction Power SCADA Equipment sides.

12.10 Traction Return: The normal and worst short circuit current levels shall be taken into account while designing Telecom Systems to take care of EMI/EMC affects.

12.11 **Electromagnetic Compatibility**: Contractors shall perform a study between Traction Power SCADA and Telecom systems and develop the Electromagnetic Compatibility Management Plans using such data as the emission characteristics, susceptibility levels, filter characteristics, physical layout and construction of their equipment, taking into consideration variation in component characteristics with frequencies. The study shall demonstrate compatibility or highlight areas of potential problems with a view to implement remedial measures in time to achieve compatibility.

12.12 Interface requirements specified above 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 coordinated;
(3) All equipment and facilities supplied under the Contracts are fully compatible with each other, whilst meeting the requirements of the respective Specifications.

12.13 Interface Requirements with Indian Railway

12.13.1 Contractor shall liaison with designated authorities in Indian Railway to design 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.

12.13.2 Contractor shall liaison with designated authorities in Indian Railway to design 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 12

13. PACKAGING, SHIPPING, STORAGE AND DELIVERY

13.1 Packaging

13.1.1 Cable Drums

13.1.1.1 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.

13.1.1.2 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.

13.1.1.3 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.

13.1.1.4 Cables shall be supplied on drums in the longest possible lengths and within practical limits. The drum when mounted on the wagon provided by the Engineer shall not exceed the specified Gauge of the railway.

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

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

13.1.1.7 The drums shall also be designed for use in conjunction with any special cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

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

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

13.1.2 Packaging of electronic equipments & other RDSO approved S&T items and its storage should be as per RDSO Guidelines issued from time to time.

13.2 Storage

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

13.2.2 The Contractor shall maintain records of stored items for this Contract and make available for the Engineer for inspection upon request.

13.3 Delivery

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

13.3.2 The Contractor shall include the delivery activities in his three month rolling programme to draw the Engineer’s attention.

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

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

13.3.5 The Contractor shall remove temporary fittings, if necessary, for delivery of his items to site and shall restore the fittings to the original state and to the satisfaction of the Engineer.

13.3.6 No dangerous goods shall be delivered to the Site.

End of Chapter 13

14. DOCUMENTATION

14.1 General

14.1.1 The Contractor shall submit a Submission Programme. The Submission Programme shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

14.1.2 The Contractor shall provide configuration management to ensure that the System is correctly configured. The Contractor shall ensure that a configuration control programme is maintained. The programme shall ensure that the configuration of each item is recorded and maintained during the life of the Contract and Defects Liability Period.

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

14.2 Submission Requirement

14.2.1 General

14.2.1.1 The Contractor shall include records of amendment in each submission with the following details:

(1) Revision history and status of the submissions;
(2) Description on changes for each revision; and
(3) Contractor's signature for authorization of the submission indicating proper design check has been carried out before submitting to the Engineer.

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

14.2.1.3 The first submission shall be revision 0 and subsequent revision shall be1, then 2, so and so forth.

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

(1) Submission number;
(2) Submission title;
(3) Revision history;
(4) Status of Engineer's Response for each revision;
(5) Submission dates and dates of return from the Engineer for each revision; and
(6) Current status.

14.2.2 Levels of Submission

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

(1) System level related submission;
(2) Equipment level related submission;
(3) Installation Design related submission;
(4) Design calculations;
(5) Management plans and procedures;
(6) Approval certificates; and
(7) Miscellaneous submission.

14.2.2.2 System level related submission shall show the total system including the configuration block diagrams, operating principle, system features and functions, capacity, expandability, interconnection within the Subsystem, between Subsystems and between other Project Contractors.

14.2.2.3 Equipment level related submissions shall show the specifications on electrical, mechanical and functionality of the equipment/materials employed for the System and the Subsystems.

14.2.2.4 Installation design related submissions shall include:

(1) Installation methods and procedures for different types of installation activities;
(2) Drawings showing the equipment locations and positions, Subsystems coverage;
(3) Schematic and wiring diagrams;
(4) Cable core plan and numbering scheme;
(5) Equipment mounting details;
(6) Configuration data, parameters and settings;
(7) Cable route drawings; and
(8) Layouts in equipment racks, in equipment rooms, trackside, and all other equipment locations.

14.2.2.5 Design calculations shall demonstrate the performance of the System and Subsystems. Detailed requirements on calculation submissions are given in respective sections of individual Subsystem.

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

14.3 As built-documentation

14.3.1 The as-built documentation shall describe the System as installed and provide sufficient information for other users, maintainers and developers to execute their responsibilities. All documentation shall be submitted for review by the Engineer, and shall include but not be limited to:

(1) Operation and Maintenance Manuals;
(2) Configuration Data Tables; and
(3) As-built drawings.

14.3.2 The configuration data tables shall be prepared for each individual Subsystem and on an item-by-item basis as well as on location basis.

14.3.3 The as-built drawings shall show the as-built details of the Works and shall include:

(1) Bill of quantity of equipment on location basis;
(2) Location and connectivity of all equipment and cables;
(3) Schematic and wiring diagrams;
(4) Cable core plan and numbering scheme;
(5) Equipment mounting details;
(6) Cable route drawings; and
(7) Layouts in equipment racks, equipment rooms, trackside and all other equipment locations.

14.3.4 Besides what is mentioned in this PS, contractor documents shall consist of management plans as stated in PS Signal. As far as possible submission requirement for both signal and telecom shall be combined as per the provision of PS signal and PS telecom and submitted to the Engineer.

End of Chapter 14

15. INSTALLATION

15.1 General

15.1.1 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.

15.1.2 The Contractor shall take every precaution to protect existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment.

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

15.1.4 The Contractor shall ensure his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.

15.1.5 The Contractor shall carry out site surveys to ensure sufficient knowledge on the Site before submitting the relevant installation drawings and installation related submissions to the Engineer for review.

15.1.6 The Contractor shall submit calculation, if required by the Engineer, to demonstrate the proposed brackets and mounting methods are sufficient to withstand the wind loading for the equipment.

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

15.1.8 The installation method statement shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.

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

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

15.1.11 The Contractor shall carry out regular site audit on both technical and safety matters and maintain records of the site audits. The Contractor shall make these records available to the Engineer for inspection upon request.

15.2 Installation Programme

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

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

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

(1) Installation schedule
(2) Milestones
(3) Site Access
(4) Interfacing with relevant Project Contractor

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

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

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

15.2.7 The Contractor shall propose contingency plan to ensure all the Milestones can be met in case there is slippage in the installation activities.

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

15.3 Installation Works

15.3.1 Installation in Equipment Rooms

15.3.1.1 For exact room dimensions the Contractor shall co-ordinate and refer to the final Station Building Plans for Telecom Equipment Rooms and Telecom Power Supply Equipment Rooms at New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar Link, New Sonnagar, New Chiraillapathu Stations and Tele Huts for installing the Telecom Equipments and Telecom Power Supply Equipments.

15.3.1.2 Provision of Electric Power, Lighting, Power Outlets, Fans, Temperature-Regulator, Air-Circulator shall be made in accordance with Employer's Requirement in PS – Signalling, PS-Electricals & General Specifications.

15.3.1.3 All floor mounted equipment cabinets at the equipment rooms shall be securely bolted to floor/ground, properly aligned and leveled.

15.3.1.4 All wall-mounted equipment shall be installed at appropriate height to avoid any hazards to the person passing by.

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

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

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

(1) Drawings showing the equipment layouts and positions of the racks, cabinets and enclosures;
(2) Racks, cabinets layout drawings showing the arrangement of individual module;
(3) Specifications, sample of all the mounting brackets and accessories;
(4) Equipment mounting and installation methods;
(5) Schematic diagrams and wiring diagrams of the System;
(6) Electrical distribution schematics within the room including the earthing details; and
(7) Cable route diagrams for cables within the room.

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

15.3.1.9 **Fire alarm system for Signal & Telecom Indoor Installation**: Fire alarm system shall be provided as per RDSO Specification no. RDSO/SPN/217/2016 (Draft) with latest

amendment at all concern rooms viz. Relay room, IPS room, Signal Batter Room, Telecom Equipment Room, Telecom Power Supply room & ASM Room as per approval of Engineer.

15.3.2 Installation around Station Areas

15.3.2.1 All the ducts/troughs for cable laying shall be provided by the Contractor.

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

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

(1) Specifications, sample of all the mounting brackets and accessories;
(2) Equipment mounting and installation methods; and
(3) Schematic diagrams and wiring diagrams of the System.

15.3.2.4 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.

15.3.2.5 All trackside equipment and the mounting method shall be designed in the way to minimise the frequency of preventive maintenance.

15.4 Cabling

15.4.1 All Outdoor Cables (Optical Fibre Cable inside Permanently Lubricated HDPE Duct, Jelly Filled Telecom 6-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 6-Quad Cable & PIJF Telephone Cables shall be laid on the opposite side of Indian Railway Track.

15.4.2 Contractor shall prepare a Cable Route Plan in consultation with Civil/Track Contractor and get it approved form the Engineer before starting the trenching work.

15.4.3 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 meter from the normal ground and suitably protected with bricks.

15.4.4 Electrical Cables (Low Tension & High Tension) shall not be laid in same trench along with Outdoor Telecom Cables. Minimum separation between Electrical Cables and Outdoor Telecom Cables shall be maintained as specified in Indian Railway Telecommunication Manual.

15.4.5 Outdoor Signalling Cables and Outdoor Telecom Cables shall be laid in separate trench. If it is inescapable to lay Outdoor Telecom Cables in separate trench, suitable separation shall be provided between the two as per the requirement of IRSEM and Indian Railway Telecommunication Manual and approved by Engineer.

15.4.6 Outdoor Cables in rocky areas shall be laid as per Chapter XIII of Indian Railway Telecommunication Manual.

15.4.7 On Bridges & Culverts, duct on the both side of Railway Tracks will be provided by Bridge Contractor for laying of cables. All Outdoor Telecom Cables (Optical Fibre Cable inside Permanently Lubricated HDPE Duct, Jelly Filled Telecom 6-Quad Cable & PIJF Telephone Cables) on these Bridges & Culverts shall be laid inside DWC Pipes. Entry/Exit of the Cables to/from Bridges & Culverts shall be suitably protected as

approved by Engineer. Contractor shall carry out necessary co-ordination with Bridge Contractor in this matter.

15.4.8 Following principles for laying of cables shall be adopted during Track/Road Crossings.

(a) The cable crosses the track/road at right angles.
(b) The cable does not cross the track under points and crossings.
(c) Boring or Trenchless technique shall be used while crosses the track/road.
(d) The cable is laid in HDPE Pipe of minimum 6 mm wall thickness/Double Wall Corrugated HDPE pipes while crossing the track/road.
(e) The cables are laid at a depth of 1.2 meter below the normal ground level.
(f) Track formation/road surface shall be restored to its original condition after laying of cables.

15.4.9 Optical Fibre Cable shall be laid in Permanently Lubricated HDPE Ducts. These Permanently Lubricated HDPE Ducts shall be laid from one Telecommunication Equipment Room to other Telecommunication Equipment Rooms. At Track/Road Crossing these HDPE Ducts shall be laid inside DWC HDPE Pipes/HDPE Pipe of minimum 6 mm wall thickness. Straight Joints for Optical Fibre Cable shall be as per Chapter XIII of Indian Railway Telecommunication Manual.

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

15.4.11 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.

15.4.12 A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. Type of labels to be used shall be got approved by Engineer.

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

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

(a) Remove such laid cable and cut into pieces of scrap of about 2 meters each;
(b) Lay new cable in lieu;

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

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

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

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

15.4.19 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.

15.4.20 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.

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

15.4.22 Underground Cable Route shall be identified by Cable Markers made from concrete or other material as approved by Engineer.

15.4.23 Contractor shall ensure that the maximum length of parallelism is suitable to the requirement of 25/2x25 kV AC traction of DFCC and 25 kV AC traction of nearby IR and shall meet the EMC/EMI requirements of individual equipments and system as a whole.

15.4.24 The Outdoor Cables (Jelly Filled Telecom 6-Quad Cable & PIJF Telephone Cables) in sufficient spare lengths shall be kept coiled in a circle of suitable diameter at 1.0 meter depth before being taken into Telecom Equipment Room/Location Boxes for termination. Such coils of cables in pits shall be adequately covered to provide protection against damage and theft.

15.4.25 All the cable entry into Telecom Equipment Room/Location Boxes etc. shall be suitably sealed to prevent entry of rodents etc.

15.4.26 Selection of cables and connectors shall be appropriate to their function. The Contractor must be able to demonstrate satisfactory usage of the type of cables proposed for use under tropical conditions, be able to comply fully with the specifications herein, and be willing to guarantee 25 years or more of service life for all the cables.

15.4.27 For Metallic Armour of the Optical Fibre Cable, Jelly Filled Telecom 6-Quad Cable & PIJF Telephone Cables an earthing and gapping policy shall be incorporated into an overall earthing policy as agreed by the Engineer.

15.4.28 Each fibre splice shall be tested to ensure correct fibre continuity and splice loss.

15.5 Marshalling and Termination

15.5.1 General

15.5.1.1 Main distribution frames, digital distribution frames and optical distribution frames shall be provided at appropriate locations for signal termination, distribution, disconnection, diversion and in-circuit testing. Intermediate termination points shall also be provided as appropriate to allow cable network flexibility.

15.5.1.2 The signal termination and distribution practice shall adopt a consistent approach for easy circuit identification and is subject to the review of the Engineer.

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

15.5.1.4 These frames shall be designed to allow repeated circuit termination and disconnection.

15.5.2 Main Distribution Frame

15.5.2.1 Main distribution frame with 20% extra capacity for future expansion shall be provided at Telecommunication Equipment Room and Central Equipment Room for the signal distribution of all voice, analogue, alarm and control circuits.

15.5.2.2 The Contractor shall provide at least five sets of the following accessories at each location where the main distribution frame is installed:

(1) Tools for circuits connection and disconnection
(2) Plug-in devices for circuit disconnection
(3) Test cords and loop-back cords
(4) Signal patch cords

15.5.2.3 The outgoing circuits connecting to external lines and all circuits liable for lightning or high induced voltage, lightning arrestors and surge protection devices shall be provided with the required earth connections. For details of Transient Protection please refer to15.8 (Transient Protection)

15.5.2.4 All voice, analogue, alarm and control circuits including spares shall be properly terminated at the main distribution frame.

15.5.2.5 The main distribution frame shall be divided into different zones for different types of circuits.

15.5.2.6 The main distribution frame shall be equipped with copper earth bar to which all cable shields shall be connected. The copper earth bar shall be connected to the earth. For details please refer to 15.7 (Earthing policy).

15.5.2.7 The main distribution frame shall be equipped with facilities such as use of different colours or markers to aid circuit pair identification.

15.5.2.8 The Contractor shall maintain records of all the circuit terminations.

15.5.3 Digital Distribution Frame

15.5.3.1 Digital distribution frame shall be provided at Telecommunication Equipment Room, Central Equipment Room and at other locations as appropriate for data circuit termination.

15.5.3.2 The Contractor shall provide at least five sets of the following accessories at each location where the digital distribution frame is installed:

(1) Plug-in devices for circuit disconnection
(2) Test cords and loop-back cords
(3) Signal patch cords.

15.5.3.3 Different modules in the digital distribution frame shall be provided for different types of data circuits.

15.5.3.4 The digital distribution frame shall be equipped with sufficient capacity for data circuits including spare circuits. The digital distribution frame shall also be equipped with an extra of 20% of termination capacity for future use.

15.5.3.5 Markers or labels shall be included in the digital distribution frame for easy identification of the circuits.

15.5.4 Optical Distribution Frame

15.5.4.1 Optical distribution frame shall be provided at Telecommunication Equipment Room, Central Equipment Room, and at other locations as appropriate for optical signal distribution and spare fibre cores storage.

15.5.4.2 The optical distribution frame shall comprise of equipment cabinet(s) or enclosures housing,

(1) Fibre splice module
(2) Fibre storage panel
(3) Optical patch panel

15.5.4.3 All fibre cores terminating in the optical distribution frame shall be spliced to factory manufactured pigtails or properly stored in the fibre storage panel.

15.5.4.4 Optical patch cords shall be provided to connect the optical terminal to the optical distribution frame and for patching within and between optical patch panels.

15.5.4.5 Fibre storage panels shall be provided in the optical distribution frame to stow the excess length of pigtail and patch cords.

15.5.4.6 All splices shall be fusion splices and heat shrink splice sleeves shall be used for splice protection and housed in a fibre splice module.

15.5.4.7 All fibre splice modules shall be either telescopic or hinged type for easy access of splice elements.

15.5.4.8 All fibre splice modules shall be equipped with built-in fibre slack take-up mechanism.

15.5.4.9 All optical distribution panels shall be either telescopic or hinged type for easy access of rear side of panels. The optical distribution panel shall be fully equipped with adapters for optical signal termination.

15.5.4.10 All spare adapters shall be protected with jackets.

15.5.4.11 One high quality optical connector such as FC/PC single mode 10/125µm type shall be standardized. 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 0.3 dB.

15.5.4.12 All optical connectors shall comply with the ITU-T Recommendation G.652.

15.5.4.13 Mating face dimensions in accordance with IEC 86B.

15.5.4.14 All pigtails and patch cords shall be properly labelled.

15.5.4.15 The optical distribution frame shall be equipped with sufficient capacity for all optical signal distribution and fibre storage. An extra of 20% capacity in each module shall be provided for future expansion.

15.6 Identification

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

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

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

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

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

15.6.6 Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical or optical laser equipment.

15.7 Earthing Policy

15.7.1 General

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

(1) To provide the safety to the operating & maintenance personnel against the electric shock on account of any potential (voltage) appearing on exposed parts with respect to earth or due to electromagnetic or due to electrostatic induction;
(2) To ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the Telecommunication equipments;
(3) To protect the equipment against build up of unduly high voltages, which can cause dielectric (Insulation) breakdown or damage to the equipment or their parts;
(4) To serve as common voltage reference point wherever required.

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

15.7.1.3 Telecom contractor shall submit, for review and approval the design for earthing, transient protection and lightning protection of all telecommunication subsystems including earthing and lightning protection of the radio tower. OEM's original data sheets of the proposed devices shall also be submitted.

15.7.2 Requirements of effective Earthing

15.7.2.1 The Earthing system shall meet or exceed the requirements of IEEE 1100, NFPA 780 and IEC 1024 or relevant International standards.

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

(1) Protect personnel and equipment from electrical hazards, including lightning;
(2) Reduce potential to system neutrals;
(3) Reduce or eliminate the effects of electrostatic and electromagnetic interference arising from within the EDFC on account of traction voltages, traction return current, electric locomotive characteristics and other extraneous sources;
(4) Provide a proper earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies; and
(5) Provide a clean zero-volt reference point where required.

15.7.2.3 The earthing system shall be so designed so as to give earth resistance within the stipulated limits at all locations and under all climatic conditions.

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

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

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

15.7.3 Earthing of indoor equipment

15.7.3.1 Main earth bus bar shall be provided in the power supply room by the Contractor. Contractor provide minimum 16 mm²cable 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 sig Contractor to extend individual earths to cables and racks/equipments etc.

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

15.7.3.3 The cabinets within a row are to be conductively connected by means of screws and contact washers. Two or more rows are interconnected via the earth bus and if necessary, also by additional earthing cables. In case that one of the cabinets/racks is removed, it must be ensured that the other cabinets in the row remain earthed

15.7.4 Earthing of outdoor installations

15.7.4.1 Outdoor installations, listed below, shall be earthed to the nearest Main earth bus bar with a minimum 16 mm² copper conductor:

(1) Metallic sheath & armouring of all cables at regular intervals;
(2) Location boxes;
(3) Racks;
(4) Video cameras;
(5) Clocks display units;
(6) any other telecommunication installation as may be necessary to cover complete scope of works defined in the Contract.

15.7.4.2 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.

15.7.4.3 An earthing system shall be designed to assure personnel safety and protection of installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances.

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

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

15.7.4.6 The Contractor shall provide two separate earth connections, a clean earth connection to the earth terminals provided inside the rooms where the telecom equipment is installed, and a main earth connection for the earthing of radio towers, antenna feeder cables, equipment chassis, etc. of the telecommunication system.

15.7.4.7 The earthing system shall meet, but not be limited to, the following:

(1) The resistance to earth of the system "earth terminal" must remain within the stipulated limits at all locations and under all climatic conditions.
(2) Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.

15.7.4.8 The earthing arrangements for Antenna Towers and Antennae shall be such that:

(1) The zone of coverage shall afford protection of all objects forming part of the Antenna Towers and Antennae including any objects near the base of the tower, and this factor shall be taken into consideration while deciding the height of the lightning conductor at the top of the tower.
(2) Earthing of VHF/UHF Antenna Feeder Cables having Copper Sheaths shall be such as to maintain a low resistance connection to the earth. Any junction forming a part of this connection shall be protected from moisture ingress by using proper wrapping, sealing with water-proof tapes, or such other measures. 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.

15.7.4.9 The earthing arrangements for Telecom Equipment shall be as below:

(1) All Telecom equipment must be protected using a mesh of copper "earth" strips of appropriate cross-sectional dimensions, forming a local clean earth bus.
(2) Each equipment rack shall be connected electrically to this bus. This bus shall be connected to the external ring earth at the shortest possible distance from two opposite points of this bus.
(3) All joints of this connection shall be protected from moisture ingress by using proper wrapping, sealing with water-proof tapes, or such other measures.
(4) The earthing connection shall be inspected periodically at intervals frequent enough to ensure that the earth connection meets all the requirements.

15.7.4.10 The metallic sheath and armouring of all cables (RF cables/optical fibre cable/others) shall require earthing.

(1) In the section earthing shall be done as per the established practices in RE areas of the Indian Railways.

15.7.4.11 The earthing electrodes for the clean earth shall be located at least 20 m away from the main earth.

15.7.4.12 The route for the clean earth shall be so chosen as to minimize the effect of any inductive interference.

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

15.7.4.14 The earth resistance at any point on the clean earth shall be below 0.5 Ohm, and that for the main earth shall not exceed 1.0 Ohm at any location and under any soil and/or climatic condition.

15.7.4.15 All metal work and metallic items shall be earthed to the main earth to ensure the safety of personnel.

15.7.4.16 The earthing methods and details shall be submitted to the Engineer for review.

15.7.4.17 Radio equipment shall be provided with isolated terminations for the connection of coaxial cables extending to equipment in external locations.

15.8 Transient and Lightning Protection

15.8.1 An effective transient protection system, complying to the following as a minimum must be provided to protect the telecommunication equipment from transients:

(4) Peak transients of up to 700 Volts on the DC Power Supply line for several microseconds.
(5) Average transient duration of 2 microseconds with a repetition frequency of 15kHz to 100kHz
(3) For short duration transients (< 5ms) the variation approaches a sine wave
(4) For longer duration transients (> 5ms) the variation approaches rectangular pulses with an initial rate of rise up to 5x10^4 Volts per second

15.8.2 Suitable electronic devices (such as silicon avalanche suppressor devices/transzorbs) having high surge handling capability, fast response time and low clamping voltage, etc; shall be incorporated in the telecommunication equipment to ensure that the latter withstands the above mentioned conditions without any damage or permanent degradation in performance throughout the system lifetime. The selection criteria for such devices shall include, but not be limited to, the following:

(1) Reverse standoff voltage shall be at least twice the maximum operation voltage;
(2) Pulse power rating shall be adequate to handle the peak pulse power of the transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from overhead traction power system;
(3) Device lifetime shall not be less than that of the system for which it affords protection.

15.8.3 Surge protection devices shall be provided at TER end and outdoor equipment end, on power and data cables extending to outdoor telecommunication equipment installations as a minimum as defined below

(1) 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;

15.8.4 Earthing requirements for each system, as a minimum, are summarized below:

Sub-system	Surge Protection for equipment in Outdoor			Surge Protection for equipment in room (indoor)		
	Equipment	Power Line	Data Line	Equipment	Power Cable	Data Line
OFC communication system	ODF	Earthing for optical fiber cable armour		SDH Node	yes	yes
				Data Network	yes	Yes
Telephone System	Outdoor telephone	Yes	Yes	LDF	N/A	yes
				MDF (incoming leased telephone line)	N/A	Yes
Clock	Slave Clocks out door	Yes	Yes	Sub-master Clock / changeover switch	No	Yes

SCADA	Depending upon the kind of interface					
Battery system				SMPS	Yes	N/A

15.8.5 Lightning Protection

15.8.5.1 While the station buildings will be provided with the lightning protection arrangements by other project contractors, the protection against lightning surges travelling through conductors into equipment shall be provided by Telecom contractor using appropriate devices.

15.8.5.2 The station buildings will be provided with the lightning protection arrangements and the protection against lightning surges travelling through conductors into equipment shall also be provided using appropriate devices.

15.8.5.3 The Contractor shall submit the proposed measures for review by the Engineer.

15.9 Housing, Enclosure and Cabinet

15.9.1 Housing, enclosure and cabinet shall be as per PS Sig. All equipment installed shall be able to withstand vibration levels likely to be experienced in railway stations and along railway track side structures.

15.9.2 All design of housing and enclosure shall be submit to the Engineer for review.

15.9.3 Unless specified otherwise, all equipment to be housed in outdoor environment (open areas, etc) shall be with IP 65 enclosures as a minimum.

End of Chapter 15

16. VERIFICATION, TESTING AND COMMISSIONING

16.1 General Guidelines for Testing and Commissioning

16.1.1 The Contractor shall perform stage-wise testing and commissioning activities in accordance with the requirements given in this Specification.

16.1.2 The Contractor shall ensure that the Engineer prior to the commencement of the test has reviewed test documentation associated with any test without objection.

16.1.3 The Contractor shall ensure the System is in a state ready for testing and commissioning before the commencement of the tests witnessed by the Engineer. The Contractor may conduct trial tests by himself before the Engineer witnesses the tests, if necessary.

16.1.4 Test results of the Contractor's own trial tests shall be made available to the Engineer on request before the tests are witnessed by the Engineer, to indicate the readiness of the System for tests witnessed by the Engineer to commence.

16.1.5 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.

16.1.6 The Contractor shall provide all necessary test instruments, special tools, emulators, simulators and test software to carry out the tests.

16.1.7 The Contractor shall provide simulation for testing in case the interfacing equipment is not available for testing.

16.1.8 The Contractor shall extend full support to the Engineer and provide all necessary facilities to enable convenient inspection of materials, work and testing.

16.1.9 The Contractor shall investigate and provide corrective actions for all the faults detected during the tests. The tests shall be resumed only after all the faults are properly cleared. The Contractor shall submit fault report to the Engineer to describe the symptom and causes of the faults and the corrective actions taken.

16.1.10 If the operation of other project contractor's system or equipment is suspected to be affected by the system during the test, the contractor shall withhold the test, investigate and provide corrective actions, if necessary, before resumption. The test shall be resumed only after the interference has been eliminated or found not to be related to the system.

16.1.11 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.

16.1.12 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.

16.2 Testing Stages

16.2.1 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

16.3 Factory Acceptance Tests

16.3.1 The Contractor shall carry out factory acceptance tests at the place of manufacturing in the presence of the Engineer.

16.3.2 The test shall include, but not be limited to, visual, environmental, electrical and functional tests on each individual equipment and associated Subsystem as well as simulation before delivery of the equipment to the site.

16.3.3 Factory acceptance test shall be carried out for equipment and cables of all the Subsystems.

16.3.4 The Contractor shall prepare and submit a Factory Test Plan at least six months before the tests. In addition, the Factory Test Plan shall also include the following:

(1) A list of equipment and cables for individual Subsystem to have factory acceptance test;

(2) Program of all the activities related to factory acceptance tests;

(3) The locations where factory acceptance tests to be carried out;

(4) The estimated duration of tests activities at each locations; and

(5) Submission schedule of all the factory acceptance test procedures for equipment and cable.

16.3.5 The Contractor shall prepare the factory acceptance test procedures for equipment and cables and submit to the Engineer for review.

16.3.6 The factory acceptance test procedures shall describe in detail all tests to demonstrate the functional, electrical and physical performance of the equipment and cable under designed environmental conditions.

16.3.7 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 Acceptance Test Procedure.

16.3.8 FAT for equipment supplied as per RDSO Specification and from RDSO approved sources shall be carried out by RDSO.

16.4 On-site Testing and Commissioning

16.4.1 General

16.4.1.1 The Contractor shall prepare and submit to the Engineer for review an On-site Testing and Commissioning Plan. On-site Testing and Commissioning shall include Installation Test, System Acceptance Test, Integrated Testing & Commissioning and Service Trial.

16.4.2 Installation Tests

16.4.2.1 Installation Tests shall be carried out on individual Subsystem location by location after the completion of equipment physical installation.

16.4.2.2 The objective of the installation tests shall be to ensure the following:

1) The equipment is installed in accordance with the reviewed Design documentation
2) The equipment is installed in accordance with the requirements detailed in this Specification
3) All cables are properly and accurately connected and terminated
4) All installation works are of acceptable workmanship

16.4.2.3 The Contractor shall develop procedures for Installation Tests and submit to the Engineer for review.

16.4.2.4 The Installation Test shall not be started unless the test procedures have been reviewed without objection by the Engineer.

16.4.2.5 All installed equipment and cables shall be physically inspected against all relevant review Design documentation.

16.4.2.6 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.

16.4.2.7 The Contractor shall verify all the connections within the antenna network and measure the attenuation and VSWR values of all the connections.

16.4.2.8 All the installation test results, physical locations of the equipment and serial numbers shall be captured in the test record forms. The Contractor shall include completed test record forms in the Test Report and submit to the Engineer for review.

16.4.3 System Acceptance Tests

16.4.3.1 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.

16.4.3.2 The Contractor shall develop System Acceptance Tests procedures for each Subsystem and System as a whole and submit to the Engineer for review.

16.4.3.3 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.

16.4.3.4 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.

16.4.3.5 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.

16.4.3.6 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.

16.4.3.7 The Contractor shall conduct end-to-end circuit test to verify the circuit integrity and electrical performance for all circuits including spare

16.4.3.8 All local alarms, control and monitoring functions shall be verified.

16.4.3.9 All equipment settings and parameters shall be verified and recorded in the reviewed test record forms.

16.4.3.10 Coverage test shall be carried out on location basis for the Radio system, if any..

16.4.3.11 All protection mechanisms such as hot-standby, parallel redundancy, automatic switchover, etc, built into the System and individual Subsystem shall be verified.

16.4.3.12 The system response time of relevant Subsystems and the System shall be tested and measured.

16.4.3.13 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.

16.4.3.14 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.

16.4.3.15 The System Acceptance Tests are considered completed only if the Engineer without objection reviews the System Acceptance Test results.

16.4.3.16 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.

16.4.4 Integrated Testing and Commissioning

16.4.4.1 The Contractor shall carry out Integrated Testing and Commissioning after the completion of the System Acceptance Tests.

16.4.4.2 The Contractor shall co-ordinate with the Engineer and with all the interfacing Project Contractors to ensure all the interface test activities are completed in accordance with the program on Completion Plan.

16.4.4.3 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.

16.4.4.4 Within one week upon completion of all interface test activities, the Contractor shall submit the test results to the Engineer for review.

16.4.4.5 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.

16.4.4.6 The Contractor shall advise the Engineer in writing the commencement date of the reliability demonstration test.

16.4.4.7 The Contractor shall submit a reliability demonstration test plan to the Engineer for review at least three months before the test.

16.4.4.8 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

16.4.4.9 During the reliability demonstration test period, the Contractor shall record details of all faults in a fault log which shall include:

(1) Date and time the fault occurs
(2) Date and time the Contractor's staff arrive on site
(3) Date and time the fault is cleared and the normal operation is restored
(4) Description of the fault
(5) Cause of the fault
(6) Equipment or component replaced

16.4.4.10 All fault logs shall be submitted to the Engineer for review.

16.4.4.11 The reliability demonstration test is considered a failure if:

(1) 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

16.4.4.12 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.

16.4.4.13 The reliability demonstration test shall be repeated on the affected Subsystem or Subsystems for another three months until the test is successfully completed.

16.4.4.14 Within two weeks upon completion of the reliability demonstration test, the Contractor shall submit the test results for the Engineer to review.

16.4.4.15 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.

16.4.5 Service Trials

16.4.5.1 The Contractor shall provide all necessary support and attendance to the Engineer during the Service Trials period.

16.4.5.2 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.

16.4.5.3 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.

16.4.5.4 The Contractor shall submit a manpower plan to the Engineer for review at least 1 month before the commencement of the Service Trials.

16.4.5.5 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.

End of Chapter 16

17. OPERATION AND MAINTENANCE SUPPORT

17.1 General

17.1.1 The Contractor shall investigate all failures, major failures, repetitive failures, design defects and provide all necessary corrective actions throughout the Defect Liability Period.

17.1.2 The Contractor shall investigate interference problems either from or to the systems of other Project Contractors and organizations other than EDFC and provide all necessary corrective actions throughout the Contract period.

17.2 Operation and Maintenance Documentation

17.2.1 The Contractor shall prepare Operation and Maintenance documentation and the Employer's Operation and Maintenance Manual Specification.

17.2.2 The first submission shall be made to the Engineer for review at least nine months prior to the start of Defect Liability Period.

17.3 Maintenance Plan

17.3.1 The Contractor shall submit a Maintenance Plan to the Engineer for review before the commencement of installation activities. Maintenance Plan shall be in line with DFCC Maintenance Philosophy.

17.3.2 The Maintenance Plan shall describe the proposed maintenance policy for preventive and corrective maintenance of the System to be followed by Employer, including, but not be limited to the following:

(1) Maintenance philosophy and approach;
(2) All necessary tasks for first line, second line, third line and corrective maintenance; and
(3) Frequency of each maintenance task.

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

(1) Equipment, subsystems covered in the task;
(2) Step by step procedure to carry out the task;
(3) Tools and test equipment list of each task;
(4) Diagrams and flowcharts for illustration, if applicable;
(5) Recovery procedures, if applicable;
(6) Precautions the maintenance personnel to follow; and
(7) Estimated duration and manpower required.

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

17.4 Software Support

17.4.1 General

17.4.1.1 The Contractor shall provide full support to the Employer and Engineer for all computer programs provided by the Contractor under the Contract.

17.4.1.2 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.

17.4.1.3 The Contractor shall provide all tools, equipment, manuals and training necessary for the Employer's staff to maintain and re-configure all the software provided under the Contract.

17.4.1.4 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; and

(c) Check sum.

17.4.1.5 The Engineer shall not be obliged to use any new version and 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.

17.4.2 Software Security Obligations

Within fourteen (14) days of the installation of any software, 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, the end user, two backup copies of the software, which shall include, without limitation:

(1) All source and executable code including all data configuration tables;

(2) All licenses in favour of the Employer for their perpetual use by DFCCIL for the entire life of the systems;

(3) All design documentation relating to the software; and

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

17.5 Supports during Defects Liability Period

17.5.1 General

17.5.1.1 During the Defects Liability Period, maintenance will be conducted by the Employer.

17.5.1.2 The Contractor shall provide workshop repair services of all defective and faulty items of the System.

17.5.1.3 The Contractor shall provide support and call-out services to the Employer as required to restore the System to normal operation in case faults and defects are found.

17.5.1.4 The Contractor shall submit a Manpower Plan showing the Contractor's organization available during the Defects Liability Period.

17.5.1.5 The Contractor shall ensure all his staff available during DLP shall be competent and with sufficient training in the responsible subsystems. CVs of the proposed staff shall be submitted to the Engineer for review.

17.5.2 Workshop Repair

17.5.2.1 The Contractor shall collect and repair defective parts that are removed from the System during maintenance.

17.5.2.2 The Contractor shall perform all necessary adjustments or alignments as 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.

17.5.2.3 The Contractor shall use only components of equal or higher specification than the original components in his repair activities.

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

17.5.2.5 The maximum turnaround time for workshop repair shall be less than 28 calendar days. The turnaround time is started to count when the defective parts are removed from the System and ended when the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer.

17.5.3 Support and Call-out Services

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

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

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

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

17.5.3.5 The Contractor's staff shall be available on Site for maintenance support within two hour upon receiving the call-out request from the Employer and shall proceed to perform corrective actions to restore the System to full normal operation.

17.5.3.6 The Contractor shall take every precaution to protect existing equipment from damage, and make good any damage caused.

17.5.3.7 Shall any abnormal system behavior like intermittent faults, interference, frequent repeated faults, etc, or the performance be found to deviate from the specified tolerances, the Contractor shall conduct investigation and report the findings to the Engineer together with the recommendation and proceed after the recommendation has been reviewed without objection by the Engineer.

17.5.4 Monthly Maintenance Meeting

17.5.4.1 The Contractor shall attend the Monthly Meeting with the Engineer to discuss the defects arising during the Defects Liability Period. The dates and agenda of the meeting shall be agreed with the Engineer.

End of Chapter 17

18. SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

18.1 Spares

18.1.1 General

18.1.1.1 The Contractor shall provide his own spares during Installation & Commissioning Period as well as during the Defects Liability Period. The Contractor shall also provide separate spares for the Employer to enable the Employer to operate and maintain the System.

18.1.2 Contractor's Own Spares

18.1.2.1 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 types and quantities with the following taken into account:

(1) Expected failure rate of the parts;
(2) Population of the parts in the System
(3) Criticality of the parts in the System;
(4) Availability and MTTR figures of the System;
(5) Spare delivery lead time; and
(6) Workshop repair turnaround time.

18.1.2.2 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.

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

18.1.2.4 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.

18.1.3 Contract Spares for Employer's Operational and Maintenance Requirements

18.1.3.1 The Contract Spares shall be as per the list specified in Annexure-4. The contractor shall submit list & quantities of each type of spare modules at least six months before start of Defect Liability Period and after submission of as built BOQ. The shelf life of the spare modules shall be mentioned by the Contractor.

18.1.3.2 Contractor shall indicate the sources of supply of all such spares modules and shall guarantee their availability during the design life of the project.

18.1.3.3 Any item not included as spare in the offer and subsequently found to be necessary during Defect Liability Period or during Maintenance (if any) shall be supplied by the contractor in sufficient quantities as per the direction of the engineer.

18.1.3.4 The Contract spares shall include, but not limited to, spare modules, sub-assemblies, special components, cables, connectors and fuses.

18.1.3.5 Spare quantities of Fibre Optic Cable and Telephone cable of each type shall be supplied as per Annexure-4.

18.2 Special Tools and Test Equipment

18.2.1 The Contractor shall provide his own test equipment and tools during the Installation & Commissioning Periods and Defects Liability Period.

18.2.2 List of minimum special tools and test equipment to be supplied by the contractor for maintenance of the system is given at Annexure-5.

18.2.3 Special tools and test equipment shall be of appropriate types and sufficient quantities to enable the Employer to carry out his own operation and maintenance of the System.

18.2.4 All special tools and test equipment shall be supplied together with all cords and connectors, operation manuals, complete diagrams, schematics, assembly and connection drawings, maintenance and calibration instructions.

18.2.5 None of the special tools and test equipment provided for the Employer shall be used on site prior to delivery to the Employer.

18.2.6 Contractor shall submit list and quantities of each type of Special Tool & Test Equipment at least six months before the start of defect liability period to the engineer. The supply of Special Tools & Test Equipment shall be completed by the start of Defect Liability period

18.2.7 Contractor shall submit list and quantities of each type of Special Tool & Test Equipment at least six months before the start of defect liability period to the engineer for review.

18.2.8 Computer based Spares and Special Tools & Test Equipment inventory management plan shall be established to manage the inventory by Employer.

End of Chapter 18

19. TRAINING

19.1 General Requirements

19.1.1 The contractor shall provide comprehensive training to the employer's staff, including employer's trainers, in accordance with the requirements contained in this particular specification.

19.1.2 The contractor shall provide competent training instructors, training manuals, training simulators, all necessary aids and materials as required for all the training courses.

19.1.3 All the training courses shall be conducted during installation period and completed before the commencement of testing and commissioning. No training course shall be started before the completion of Design phase.

19.1.4 The training shall be carried out either at Site or in DFCCIL Corporate/Regional Office. The cost of travel and boarding/lodging of Employers Personnel shall be borne by DFCCIL.

19.1.5 The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possess good communication skills in English.

19.1.6 The training instructors shall be either the system designer or engineering staff of the Contractor, the contractor's subcontractors or the equipment manufacturers.

19.1.7 The training courses and/or sessions shall include system performance requirements and all major equipment and works engineered by the Contractor. The training shall be in English.

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

19.1.9 The Contractor shall be required to arrange training to the Employer's staff in respect of design, installation, testing and commissioning of the System and each subsystem.

19.2 Training Period

19.2.1 Training in India shall be 50 training instructors' man days. The Class size will be maximum of 30 trainees.

19.3 Training Materials

19.3.1 At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form allow easy future reproduction.

19.3.2 The format of the trainer's guides and training manual for trainees shall be submitted to the Engineer for review.

19.3.3 The Contractor shall, for each course, distribute two sets of trainer's guides, one set of training manual for each trainee, two sets of trainer's guides and three additional sets of training manual to the Engineer before the commencement of the training course.

19.3.4 All the training materials shall be accurate and match with the actual Design of the System.

19.4 Training Records

19.4.1 The Contractor shall devise a system, standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees. The system and standards shall be submitted to the Engineer for review four weeks before the commencement of the training course.

19.5 Training Plan

19.5.1 Within sixty days after the Commencement Date of the Works, the Contractor shall submit a Training Plan to the Engineer for review.

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

(1) Program of the training courses and submission schedule of the training materials;
(2) Overview and description of objectives of each training course;
(3) Location where the training courses to be conducted;
(4) Set ups for practical exercises;
(5) Contractor's training organization chart, including the role and Responsibilities of individual key persons;
(6) Qualifications and experience of the training instructors; and
(7) Details of training simulators to be provided or developed, if applicable.

19.6 Training Courses

19.6.1 The Contractor shall provide training courses for each of the Subsystems, including, but not be limited to:

(1) Optical Fibre Communication System ;
(2) Data Networking System
(3) Telephone System and Direct Line & Emergency Communication System;
(4) and Master Clock System.

19.6.2 Different types of training courses of each Subsystem shall be provided for staff from different disciplines. Operations training courses shall be provided for the operations staff. System engineering and maintenance courses shall be provided for engineering and maintenance staff. The Employer's Training Instructors shall attend all types of training courses such that the Employer's Training Instructors shall be able to subsequently train the Employer's staff in all aspects of operation and maintenance of the System.

The Contractor shall determine the number of classes for each type of training course to ensure the objectives of the course can be met.*

19.6.3 Operations & Troubleshooting Training Courses

19.6.3.1 The operations & troubleshooting training courses shall be developed to provide all necessary knowledge and skills for operations staff of the Employer to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the training course shall include the following as minimum:

(1) Overview of the Telecommunications System;
(2) Brief description of the operation principle of the Subsystem;
(3) Operational features and functions;
(4) Familiarization 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 situation

(8) Procedures for recovery from minor or simple faults; and
(9) Use of Operation and Maintenance Manuals and documentation.

19.6.3.2 Particular exercises shall be included in the operations training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple faults recovery.

19.6.4 System Engineering Courses

19.6.4.1 The system engineering courses shall be developed to provide all necessary knowledge and skills:

(1) To perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits; and
(2) To perform full maintenance, including both preventive and corrective maintenance, on the System.

19.6.4.2 The Contractor shall determine the content of the courses and the courses shall include the following as minimum:

(1) Overview of the Telecommunications System;
(2) Background theory;
(3) System features and functions;
(4) System configuration and operation principles;
(5) Description of system components and equipment down to card or module level;
(6) Test and commissioning procedures;
(7) Use of test equipment and special tools;
(8) Reading and interpretation of alarm indications, messages and print-outs;
(9) Preventive maintenance procedures;
(10) Fault diagnosis, troubleshooting and corrective maintenance procedures;
(11) Equipment settings and parameters configuration;
(12) Use of equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;
(13) Methods and procedures to provide new circuits, system expansion and enhancement;
(14) Data, software backup and loading; and
(15) Use of software such as peripheral control and configuration, utility, database structure, generation and modification.

19.6.4.3 Practical exercises shall be provided for each trainee to practice the following as minimum:

(1) Use of test equipment and special tools;
(2) Preventive maintenance;
(3) Fault diagnosis and troubleshooting with induced faults set by the Contractor to simulate real-life situation; and
(4) Faulty modules or cards replacement and restore the system to normal operation.

19.7 Course Evaluation

19.7.1 The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Engineer for review four weeks before the commencement of the training course.

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

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

19.7.4 The contractor shall submit the course evaluation criteria to the Engineer for .approval.

End of Chapter 19

Annexure 1

EPABX SWITCH & TELEPHONE SET LOCATIONS AND QUANTITY

SN	EPABX Switch Location	Telephone Set					
		Service Building	Station Building	Residential	Nearby Auto Hut	Nearby IR Stations	Total EPABX Telephones
1	New Chiraillapathu	15	15	0	0	20	50
2	New Sonnagar	15	15	30	10	10	80
3	New Sonnagar Link	10	10	0	15	15	50
4	New Ganjkhwaja	10	10	30	20	10	80
5	New ERC Mughalsarai	10	10	0	15	15	50

Note: Total number of telephones shall remain fixed, however distribution may change as decided by the Engineer.

Annexure 2

MMI PROVISION

MMI Provision Schedule			
Location	**Position**	**Dispatcher's Consoles**	
		Type	**Quantity**
OCC	**Traffic Controller**	**Direct Line Console (100 LINES)**	**1**
	Traction Power Controller	**Direct Line Console (100 LINES)**	**1**
	Fault Management Controller (S&T)	**Direct Line Console (100 LINES)**	**1**
	Track (Civil) Controller	**Direct Line Console (100 LINES)**	**1**
Each DFC Station	**New ERC Mughalsarai, New Ganjkhwaja, New Sonnagar, New Chiraillapathu and New Sonnagar Link.**	**Direct Line Console (30 LINES)**	**5**

Note: Total number shall remain fixed, however distribution may change as decided by the Engineer.

Annexure 3

CLOCK SCHEDULE

SN	Name of Station	Station Control Room		Station Building	MD BUILDINGS
		Digital	Analog	Digital	Digital
1	New Chiraillapathu	1	1	6	-
2	New Sonnagar	1	1	6	-
3	New Sonnagar Link	1	1	6	-
4	New Ganjkhwaja	1	1	6	-
5	New ERC Mughalsarai	1	1	6	-
6	OCC	5	1	6	-

Note: Total number shall remain fixed, however distribution may change as decided by the Engineer.

Annexure 4

CONTRACT SPARES

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
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	Layer-2 Switch	10% of the total population for each type
6	Layer-3 Switch	10% of the total population for each type
7	Notebook computer loaded with OFC NMS software	2
8	Dispatcher's Console Complete for OCC	1
9	Dispatcher's Console Complete for SCR	1
10	Direct Line Communication Switch Cards	10% of the total population for each type
11	Notebook computer loaded with EPABX NMS Software	1
12	Exchange Subscriber Line Cards	10% of the total population for each type
13	EPABX Junction Line Cards	10% of the total population for each type
14	EPABX (dispatcher) Junction Line Cards	10% of the total population for each type
15	EPABX/Dispatcher switch System Control & Power Control Cards	10% of the total population for each type
16	Digital Telephone Instruments	10% of the total population for each type
17	Analogue Telephone Instruments	10% of the total population for each type
18	Direct Line Telephone Instruments other than consoles	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	All type of replaceable / plug-in modules for Centralized Voice recording System	10% of the total population for each type
22	SMPS Based Float Cum Boost Charger (48 V DC)	10% of the total population for each type
23	All type of replaceable/plugin cards /modules for SMPS based float cum boost charger	10% of the total population for each type
24	Maintenance Free Batteries	10% of the total population for each type
25	Replaceable / plug-in cards for Master Clock	1 card at least each

26	**Station Sub-Master Clock Complete**	**10% of the total population for each type**
27	**Digital clock units**	**10% of the total population for each type**
28	**Analogue Clocks**	**10% of the total population for each type**
29	**Fuses of all types**	**10% of the total population for each type**
30	**Terminals of all types**	**10% of the total population for each type**
31	**Transient /Surge protection device**	**10% of the total population for each type**
32	**Optical Distribution Frame**	**10% of the total population for each type**
33	**Telephone Cable Termination frame**	**10% of the total population for each type**
34	**Copper Cable Jointing Kits for all sizes of cables**	**10% of the total population for each type**
35	**Splicing Kits for OFC**	**10% of the total population for each type**
36	**Optical Fibre Cable**	**10 km for each type**
37	**Optical Fibre Splice Box & remake loops**	**10% of the total population for each type**
38	**Optical pigtail cables**	**10% of the total population for each type**
39	**Outdoor Telephone Cable**	**10% of the total population (km) for each type**
40	**Indoor Telephone Cable**	**10% of the total population (km) for each type**
41	**6 Quad Cable**	**10% of the total population (km) for each type**
42	**All type of Connectors/Dummy Loads**	**10% of the total population for each type**
43	**Emergency socket**	**10% of the total population for each type**
44	**Portable emergency telephone set**	**50 Nos.**

Annexure 5

SPECIAL TOOLS & TEST EQUIPMENTS

SN	Item	Unit	Total Quantity
1	E 1 Analyser	Nos.	1
2	Auto fusion splicing machine complete.	Nos.	2
3	SDH Analyser	Nos	1
4	OTDR mini	Nos.	2
5	OTDR main frames	Nos.	1
6	Optical fiber tool box	Nos.	3
7	Transmission measuring set	Nos.	2
8	Digital multi-meter	Nos.	6
9	Earth tester	Nos.	2
10	Megger 500 Volts	Nos.	2
11	Mega OHM meter	Nos.	1
12	Optical power source	Nos.	2
13	Optical power meter	Nos.	2
14	Optical variable attenuator	Nos.	2
15	PCM channel analyzer with printer	Nos.	1
16	Cable tool kit	Nos.	2
17	Mechanical splies	Nos.	2
18	Cable route locator	Nos.	2
19	Portable Generator 1.5 kVA	No.	2
20	Emergency light	No	4
21	Ethernet analyzer	No.	2
22	Tarpoline tents	No	1
23	Duplex VHFsets	No.	2
24	Walkie talkie sets	No.	4
25	General purpose telecom tool kit.	No.	6
26	Power supply (Variable) 0 to 60 Volt DC	No.	1
27.	Vacuum cleaner	No.	2
28	Drilling machine with hammer action capable of working on wood, metal, concrete complete with chuck drill bits	No	2
29.	VHF Power Meter with all accessories	Nos	1

Annexure 6

VHF TRANSCEIVERS

SN	Item	Unit	Total Quantity
1	5 Watt Handheld VHF Transceivers complete with battery and carrying case	Nos.	100
2	Battery charger for VHF hand held transceivers-Multi Unit Charger (for charging minimum 5 units)	Nos.	20
3	Battery charger for VHF hand held transceivers-Single Unit Charger.	Nos.	100
4	Supply & installation of VHF 25 watt transceivers complete with antenna cable and power supply	Nos.	6
5	Supply of VHF 25 watt transceivers complete with antenna cable and power supply (Antenna Mounting Poles and other accessories shall be supplied)	Nos.	5

SECTION V (B)

PARTICULAR SPECIFICATION

VOLUME 9

PARTICULAR SPECIFICATION

FOR

ELECTRICAL WORKS

Table of Contents

1 General

1.1 Objective

1.1.1 This document defines the objectives, guidelines and requirements for the design, supply, installation, testing and commissioning of Traction Power Supply System, Receiving Sub-station (RSS), Traction Substation (TSS), Sectioning Post (SP), Sub Sectioning Post (SSP), Supervisory Control and Data Acquisition (SCADA), Overhead Line Equipment (OHE) and General Power Supply work on MGS-SEBN & CPBH (excluding New Karwandiya – New Durgauti section)double line Section in the Eastern Dedicated Freight Corridor.

1.1.2 The works to be executed under the Contract include system and equipment design, manufacturing, verification, delivery, installation, testing including integrated testing and commissioning, repair of defects during defect liability period, supply of spares, T&P and M&P, training of Employer's Personnel and documentation for a complete System necessary to deliver the requirements of this Specification.

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

a.) Employer's Requirement: Particular Specification.

b.) Employer's Requirement: General Specification.

c.) Indian Electricity Rules

d.) CORE Specification

e.) RDSO Specification.

f.) AC Traction Manual.

g.) RDSO Draft Specification.

h.) CPWD Specification.

i.) Institutional Standard referred herein.

j.) Indian Standard.

k.) International Standard.

1.2 Relevant Document

1.2.1 This Particular Specification (PS) shall be read in conjunction with General Conditions of the Contract (GCC), Special Conditions of Contract (SCC), the General Specification (GS) and any other document forming part of the contract.

- END OF CHAPTER -

2 Overview of the Project

2.1 General

2.1.1 Abbreviation and definitions related to the contract are given in Annexure - I and II.

2.2 Eastern Dedicated Freight Corridor

2.2.1 The Project entails construction of double-track electrified railway lines capable of handling 32.5 ton axle load. The bridges and other structures will be designed to allow movement of 32.5 ton axle load while the track structure will be initially designed for 25 ton axle load, operating at maximum train speed of up to 100 km/hr.

2.2.2 The Overhead Equipment Design will provide for movement of freight operation with 5.1m MMD and use of regulated polygonal OHE with contact wire at a height of 5.6m above rail at support. The overhead equipment shall be designed with clearances as provided in the Standard Schedule of Dimension of Eastern Dedicated Freight Corridor (EDFC) - 2013 for maximum speed of 120 kmph.

2.2.3 Trains will be hauled by 9000/12000HP, 3 phase Electric Locomotive and existing IR Electric Locomotives.

2.2.4 The formation of single trains shall be 6000T trains. Trains may be coupled in formation of twin trains hauling 12000T bulk with one engine in the middle of the train or two engines in front.

2.2.5 The Freight Corridor will utilize 25kV AT feeding system on the main lines and 25kV conventional systems in yards.

2.3 Description of Section

DFCCIL firstly intends to bring in to use the section New Karwandiya to Durgauti for which the contract has already been awarded to M/s L&T in the year 2013. This section New Karwandiya to Durgauti (approx. 66 Km) is likely to be commissioned shortly. The remaining proposed section i.e. between **MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION** (excluding New Karwandiya to New Durgauti) will be done in the present contract.

2.4 Operational Control Centre (OCC) (constructed by other designated contractor of EDFC-1)

2.4.1 The Integrated Operation Control Center (OCC) for the Eastern Dedicated freight corridor has been planned at Allahabad. The building construction and associated E&M work shall be executed by Designated Contractor under EDFC-1 Contract Package 104. However, the provision of SCADA equipment and other associated works for the present contract at OCC shall be under the Scope of the system Contractor as described in relevant chapters of this PS.

2.4.2 **OCC Arrangement and Features are as below:**

(1) OCC (Theatre) caters to the entire requirement and technology considered to monitor, control & management of train movement and all facilities required to enable it, while ensuring that personal manning the facility can easily access all available information to make decision as may be required.

(2) For this purpose, information shall be displayed on two systems, one that is common to all and displayed on the video wall provided by system Contractor and the second through display monitor placed on the console/ Work station of each operator. Details are available in relevant chapter.

(3) OCC layout has been designed under EDFC-1 to provide un-obstructed view of the displays for all operators of OCC while providing adequate space for their

consoles and movement. The floor shall be raised to accommodate all cables & to have view of all mimic panel. The theatre shall be acoustically designed with effective lighting. Horizontal & vertical ducts shall be provided for cables from ground floor to the theatre as requirement of Electrical, Signaling, Transmission, Power departments in consultation with them.

(4) The OCC SCADA equipment shall be organized in OCC Theatre and various rooms designated for SCADA purpose. The existing UPS power supply shall be extended to various rooms for SCADA equipment power as required. Also the communication network shall be established in OCC. The Contractor shall also prepare and design optical backbone network.

2.5 Power Supply for the Section

2.5.1 Power supply at 220 kV will be obtained at Durgauti Receiving Sub-station from PGCIL grid at Pusauli through 220 kV 3-phase Double Circuit Transmission line. Durgauti RSS shall be 220/132 kV and provide 132 kV supply for TSSs. At Durgauti there shall be integrated arrangement of RSS and TSS within the same complex. The detailed scheme should be prepared and discussed in detail with Engineer/Employer for approval.

2.5.2 The power supply will be stepped down at RSS and TSS as follows:

(1) From 220 kV to 132 kV in Receiving Sub-Station

(2) From 132 kV to 25kV AT supply for traction OHE in TSS

(3) 240V, single phase AC for auxiliary supplies for feeding wayside S&T installations.

2.6 Key Challenges

2.6.1 The OHE traction power supply system, general power supply systems and SCADA system for Eastern Dedicated Freight Corridor shall be designed following Good Engineering Practices. The following are the Challenges presented to the Contractor:

a) Presently, SCADA for the section NKWD-DGO is located at OCC Mughalsarai. The same is to be upgraded/modified/integrated with the present section and is to be commissioned at OCC Allahabad.

b) The layouts of RSS, TSS, SSP and SP shall be planned within either the existing land procured or the right of way.

c) Various interfacing issues with other Contractors and power utilities are required to be resolved to ensure timely completion of the Works. Whilst some of the interface issues have already been addressed, some of them are yet to be identified and finalized. It is the Contractors responsibility to ensure that all interface issues are clearly defined and agreements sought from all relevant other Contractors and State Power Companies and adjoining Indian Railway authorities in accordance with the Employer's Requirement. Interface Management Plan is to be submitted by the contractor for this purpose.

d) Laying of main (+25kV AC) and feeder (-25 kV AC), 240V AC, 110V DC and control cables shall be segregated from each other within RSS, TSS, SSP, SP, Crossing stations, Junction stations, cabins and Line side installations. Liaison with the Civil Contractors shall be undertaken to ensure that workable solutions for cable installation are established in advance.

e) The entire Scope of Works shall generally meet design requirements of safety and Protective provisions including Fire safety in accordance with National Building Code and Indian Electricity Rules.

- END OF CHAPTER -

3 Scope of Works

3.1 General

3.1.1 The Scope of Work to be performed under the contract (hereinafter referred to as "the Scope of Work") includes Design, Procurement of Equipments, Components, Manufacturing, verification, Delivery, Construction, Installation of Equipments, Testing, including Integrated Testing, Commissioning, Technical Support, training of Employer's Personnel and documentation for a complete system along with OHE, 220/132 kV Receiving Sub-Station, Traction Power supply from 132kV Traction Substations, through 25kV AT System, complete with Supervisory Control and Data Acquisition System (SCADA), general power supply installations for Mughalsarai – New Sonnagar and Chirailapathu (excluding New Karwandiya – Durgauti) Section.

3.2 Design

3.2.1 The Contractor shall satisfy himself that the capacities, ratings and quantity of equipments as specified herein meet the Requirements of the Eastern Dedicated Freight Corridor, which are based on Simulation Report of New Karwandiya- Durgauti section.

3.2.2 Contractor's Responsibility for discrepancy:

(a) All designs and drawings submitted by the contractor shall be based on a thorough study and shall be such that the contractor is satisfied about their suitability. The Engineer's approval will be based on these considerations. Notwithstanding the approval communicated by the Engineer, during the progress of the contract for designs and drawings, prototype samples of components, materials and equipment after inspection of materials, after erection and adjustments to installations, the ultimate responsibility for correct design and execution of work shall rest with the contractor.

(b) The contractor shall be responsible for and shall bear and pay the costs for any alteration of works arising from any discrepancies, errors or omissions in the design and drawings supplied by him, whether such designs and drawings have been approved by the Engineer or not.

3.3 Scope

3.3.1 DFCCIL firstly intends to bring in to use the section New Karwandiya to Durgauti for which the contract has already been awarded to M/s L&T in the year 2013. The section New Karwandiya to Durgauti is likely to be commissioned shortly.

The remaining proposed section i.e. between **MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION** (excluding New Karwandiya to Durgauti) will be done in the present scope of work, in addition to other associated works which are as under:

a) Scope of work includes:

- All the works pertaining to OHE as per the Employer's Requirement.
- Traction SCADA of NKWD-DGO to be integrated/upgraded with the present section and commissioned at OCC/ALD.
- Non- Traction SCADA of NKWD-DGO to be integrated/upgraded with the present section and commissioned at OCC/ALD.
- Earthing and Bonding Arrangements.
- All the works pertaining to General Power Supply.
- All the works pertaining to RSS and TSS arrangement at Durgauti.

- All the works pertaining to Traction power supply and its commissioning.
- Integrated testing and commissioning of the whole 25 KV AT Feeding System as per the Employer's requirement.

3.3.2 The Contractor's scope of work shall include but not be limited to the following Works:

a) One Receiving Substation (220/132 kV) shall be outdoor type which includes interfacing works with PGCIL for 220 kV double circuit incoming line and with IR for outgoing feeder at 132kV.

b) One Traction Substations (TSS) (132kV/55kV) TSS shall be outdoor type located at surface level.

c) One Sectioning and Paralleling Posts (SP) of outdoor type located at surface level.

d) Three Sub-Sectioning and Paralleling Posts (SSP) of outdoor type located at surface level.

e) Autotransformers at each TSS, SP and SSP.

f) Preparation of General Traction Power Supply Diagram based on the ground survey and the Traction Power Load requirement for acceptance by the Engineer as a basic design for finalizing the Construction drawings for the Traction Power Supply Installation.

g) Complete Cable and cross-feeder network and cable support system including the following:

i) 25kV AC cable/ overhead connection from TSS, SP & SSPs to overhead feeder and current collection system.

ii) Return current cabling and Bonding along the alignment, and in yards.

iii) Autotransformer connections to the rail.

h) Complete 25kV AT Overhead Equipment (OHE) system on main lines of Eastern Dedicated Freight Corridor including conductor type, sizes, and tensions as indicated in this Particular specification.

i) 25kV Overhead Equipment (OHE) system for loop lines in Junction & Crossing Stations including the connection chords to Indian Railways. The conductor type, size and tensions are to be kept the same.

j) Low voltage supply arrangement at 240V from 25kV OHE through outdoor structure mounted auxiliary transformers to level crossing gates, stations/cabins, signaling & telecom huts along the track and emergency supply at stations.

k) The Auxiliary Transformers shall conform to specification no. ETI/PSI/15(8/03) and mounting arrangement shall be similar to ETI/PSI/0312 (Mod. B). The efficiency of the auxiliary transformer shall be governed by the total losses at 50% and 100% loading as per the formula given below:

$$\text{Y0 50\%} = \left[\frac{\text{Kxo} - \text{Kx1}}{\text{Kx2} - \text{Kx1}}\right] x \left[\text{L2} - \text{L1}\right] + \text{M1 X1}$$

$$\text{Y0 100\%} = \left[\frac{\text{Kxo} - \text{Kx1}}{\text{Kx2} - \text{Kx1}}\right] x \left[\text{L2} - \text{L1}\right] + \text{M1 X1}$$

Where:

K = kVA rating of transformer

L = losses

M1 = Maximum losses for a given star rating

Xo = kVA rating of Non-Standard Rating Transformer

X1 = kVA rating of Standard Rating Transformer below Xo

X2 = kVA rating of Standard Rating Transformer above Xo

L2 = Maximum losses for a given star rating Standard Rating Transformer above Xo @ a particular loading

L1 = Maximum losses for a given star rating Standard Rating Transformer below Xo @ a particular loading

M1X1 = Maximum losses of X1@ a particular loading for a given star rating

l) All civil works or modifications required for installation of the equipment and restoring to final finishes. This shall include but not limited to preparation and leveling of ground, ground investigation, hydrological studies, fill to lift land above water table, trenches, cable trenches & ducts in both buildings and within the right of way, buildings, fences, drainage, OHE foundations, traction equipment/ component foundations and containments.

m) All overhead equipment structures foundations along the alignment of this section of Eastern Dedicated Freight Corridor (including stations and connections to Indian Railways).

n) Design of earthing and bonding arrangement for OHE through computer simulation study.

o) All earthing and Bonding pertaining to traction system including but not limited to connection to impedance bonds, terminal bonds and buried earth conductor.

p) Protective provisions relating to electrical safety and earthing.

q) Mitigation measures from EMI effects on the systems adjoining signal & telecom, power circuits of Indian Railways.

r) Installation of check meter on the 220 kV incoming side in a separate cubicle at Receiving Sub-Station which should have communication with OCC through SCADA and Tariff metering for 132 kV outgoing feeder bays.

s) Power conditioning equipment at TSS/RSS to improve power quality.

t) Spare parts, special tools, testing, diagnostic equipment and measuring instruments, M&P.

u) Furniture, shock treatment charts, rubber mats, firefighting, first aid boxes and danger notice plates etc.

v) Site facilities for the Employer/Engineer's Personnel.

w) Signs, labels and notices.

x) SCADA of the section is to be integrated/upgraded with existing NKWD-DGO section and commissioned at OCC Allahabad for entire Mughalsarai–Sonnagar/ Chirailapathu Section.

y) Protection system for the section including RSS, TSS, SP and transmission line etc.

z) General Power Supply.

aa) Documentation.

bb) Interface management with IR's existing line and adjoining sections of DFCCIL.

cc) Solar power system as specified.

3.4 Services

The Services to be performed by the Contractor shall include, but not be limited to the following:

a) Design, supply, installation, testing including integrated testing and commissioning of the complete system as brought out above.

b) Ground Investigation including, survey, design, identification of locations and installation of foundations for trackside equipment and for any other equipment in RSS, TSS, SP, SSPs.

c) System operations.

d) Prototype testing and FAT as per test plan.

e) Training for Employer's Personnel.

f) Assist in obtaining clearances and submittal of information asked for by statutory bodies (e.g., Government of India, Ministry of Railways and Electrical Inspector to Govt. of India (EIG), Statutory Bodies etc. as directed by Engineer).

g) Provision of Integration Test Plans for Commissioning of the Electrification Works. Decommissioning, removal and/or responsible for disposal of temporary works.

h) Defects liability of Permanent Works after commissioning as stipulated in the General Conditions (GC).

i) Video Surveillance system for Traction Substation (TSS) and Receiving Sub-Station (RSS) as per the relevant chapter of PS Telecommunication. For Video Surveillance system TSS/ Karwandiya is also to be covered.

3.5 Documentation

3.5.1 Following Contractor document shall be approved by Engineer with the consent of Employer:

a) Design Manual.

b) Earthing Bonding Management Plan

c) General Traction Power supply diagram and sectioning diagram.

d) Pollution Map of the section.

e) Protection system scheme and its calculations.

f) System SCADA.

g) EMC control and Management Plan.

h) Interface Management Plan.

i) Prototype test Plan.

j) Power quality and power correction methods.

k) Installation and commissioning plan.

l) Factory acceptance test

3.5.2 Following Contractor document shall be approved by the Employer to be submitted through Engineer:

a) Type tests

b) Training plan

c) Operation and Maintenance plan.

3.5.3 The documentation to be delivered by the Contractor shall include, but not be limited to, the following items**:**

3.5.3.1 Design Stage

a) Design philosophy adopted, in the form of Design Manual

b) Voltage unbalance at point of common coupling (PCC) with power supply authorities.

c) Fault level and short-circuit calculations.

d) Rail accessible and Touch Potential under normal and fault conditions. Earthing requirements and calculations of safe touch and step potentials for the entire System.

e) Earthing and Bonding Management Plan

f) Equipment ratings, Specifications with Schedule of Guaranteed Performance (SOGP).

g) Design of connection for 220kV intake including control and protection strategy between the Receiving Substation and the Power Utilities equipment.

h) Pollution mapping of the section for identification of polluted zones.

i) Design and proving protection systems and their calculations.

j) Power Quality and its correction methods.

k) Lightning protection measures.

l) The Contractor shall undertake Catenary-Pantograph Dynamic Interaction (CPDI) simulation study for the MGS-SEBN & CPBH (excluding NKWD-DGO section) using a proven and fully validated computer based Multi Train Simulation Software. Technical criteria for the interaction between pantograph and overhead contact line are stipulated in EN 50367 and EN 50119.

m) Detailed design drawings and reports including civil works.

n) Detailed interface reports and interfacing design drawings and interface matrix.

o) Effect from adjacent 25 kV AC electrified lines.

p) EMC Control and Management Plan.

q) Systems integration plan.

r) Integration testing plan.

s) Detailed Design of Ancillary Works.

t) Study of size and types of cables required for the project.

u) SCADA Scheme.

3.5.3.2 Construction Stage

a) Construction and Installation Plan.

b) Factory Acceptance Test Plan and other test plan for equipment and system.

c) Records and drawings of equipment to be installed.

d) Inter connection drawings.

e) Site test report of equipment.

f) Detailed Earthing and Bonding plans as per approval at design stage.

g) Updated EMC Control Plan and certificates.

h) Operation and Maintenance Manuals covering Installation, Operation and Maintenance Instruction of all equipment.

i) Testing and commissioning documents.

j) As built drawings including interface drawings.

k) The Contractor shall provide furniture at the RSS, TSS and OCC/ALD as approved by the Engineer.

l) The drawings and documents to be submitted for each stage of construction shall be proposed to the Engineer for his approval and subsequently used for construction.

m) Other documentation as required, by the Employer.

n) All other records of construction, including hidden parts.

3.6 Items of Work Excluded from Contract

3.6.1 The following items of work associated with the System will be provided by other Contractors and are excluded from the Contract. However, the Contractor shall provide timely inputs such as necessary drawings, instructions, hardware and materials to the relevant other parties and other contractors, as required to ensure overall objective of timely completion of the work.

a) General power supply distribution, wiring, lighting of station and residential buildings/ quarters as per interface matrix (as Annexure XI).

b) Electrification works pertaining to yard modifications on IR

c) Transmission line.

- END OF CHAPTER -

4 Design and Performance Requirements

4.1 General

4.1.1 The design, supply, installation, testing and commissioning of the RSS, Traction power supply system, OHE, SCADA and general power supply shall meet the design and performance requirements specified in this Specification. Design shall include plans/drawings/specs of systems/sub-systems, mechanical details, FEM analysis, design life, ordering particulars for items, OEM particulars, name-plate data, maintenance and service manuals.

4.2 Design Environment

4.2.1 The traction power system shall be fully operable and maintainable as per the climatic and atmospheric conditions given in Annexure-III.

4.3 Salient Features of the proposed section of Eastern Dedicated Freight Corridor System:

4.3.1 The salient features of the proposed section of Eastern Dedicated Freight Corridor are as follows:

(I)	Gauge	1676mm
(II)	No. of tracks	2
(III)	Shortest radius of curve	700m on main lines and on Depot and yard lines
(III)	Maximum gradient	1:200 compensated
(IV)	System of current collection.	Overhead Equipment
(V)	On Main Line	25kV AC AT feeding system regulated polygonal type OHE system
(VI)	On lines other than main line	25kV AC regulated polygonal type OHE system
(VII)	Design Speed Main for Line OHE	120 km/h

4.4 Basic Design Philosophy and Requirements:

4.4.1 Applicable Codes and Design Standards

a) The design criteria shall be based on Standards specified in Annexure IV to Annexure X and relevant clauses of this specification or other internationally recognized standards.

b) Unless otherwise stated, the electrical System shall be governed by all applicable local codes, codes of practice, regulations and standards (all latest) issued by local agencies given in Annexure-X. Local codes, regulations and standards shall take precedence.

c) Software used for the design shall be proven software and with validation certificate from the client with the list of projects, where it has been successfully used.

4.4.2 Proven Design & Cross Acceptance Criteria

a) The System, including all sub-systems and Equipment shall be of approved RDSO design/ specifications, wherever applicable and shall be subjected to prototype testing as per relevant RDSO Specifications.

b) Prototype test report/certificate for offered item is to be submitted. Fresh prototype test is to be conducted, if the same has not been carried out:

(i) In last three (3) years from one month prior to date of Bid opening or later;

(ii) Considering the environmental conditions as specified in this PS.

c) Cross acceptance criteria will be applicable on items not covered by RDSO/CORE specification and items being adopted for the first time. The Contractor has to develop design and specifications for these items based on draft specification/ functional requirement, if available, and prepare detailed specification for approval of the Engineer with the consent of Employer.

d) The cross acceptance criteria shall be as under:

'Similar equipment or sub-system of equipment of same or higher rating should have been in service on AC Traction System for at least FIVE years prior to date of Bid opening of this project work. The Contractor shall furnish the details of its proven performance in English (certificate from the user railway) for such items.

e) The contractor shall procure these materials from the sources who meets the following criteria:

i) Five years satisfactorily performance for similar or higher rating of same type of item on any A.C traction system.

ii) Must have supplied quantity equivalent to 100% quantity used in this Contract to be used in this contract in last five (5) years.

iii) The contractor should purchase material from sources that have infrastructure for testing facility as per relevant Schedule of Technical Requirement (STR) of RDSO, if exists.

iv) Prototype test certificate for such items, if carried out in last five (5) years for same capacity, otherwise fresh prototype test shall be carried out for same capacity.

f) Any approval to the prototype tests by the Employer in no way would absolve the Contractor of his responsibility under the terms of the contract for the equipment.

4.4.3 Procurement of Materials for Electrification Works

Material used in the work shall be procured from RDSO/CORE's approved Part-I vendors only, wherever applicable. If no approved vendor exists in Part-I, then material may be procured from Part-II approved vendors. No material shall be procured from other sources if approved Part-I and Part-II vendors of RDSO/CORE exists. Cross acceptance criteria as listed in para 4.4.2 shall be applicable on items not covered in RDSO/CORE specification are being adopted first time.

4.5 System Integration Process

4.5.1 The Contractor shall systematically identify and formally document all design, manufacturing, Construction/Installation and operational interfaces between equipment within the System, and between the Systems and external systems, facilities, operations and the environment likely to affect or be affected by the System.

4.5.2 Responsibility for interface management and control shall be listed out, such that every identified interface has a defined resolution process that can be monitored. This may be covered in interface Management Plan.

4.5.3 The Contractor shall define methods to confirm compatibility between System equipment and carrying out integration tests at different stages of the design and interface management process to demonstrate that all equipment functions perform properly, both individually and as part of the complete System.

4.6 Design Submission Requirements

4.6.1 The Contractor shall perform his designs for the Contract in accordance with the requirements of this document following the best practices in the industry. The Contractor shall submit to the Engineer relevant design information as identified under each stage. Such submissions shall incorporate the relevant applicable Standards.

4.7 Traction Power Supply Performance Requirements

The following data shall be used for all normal and emergency performance requirements of Traction Power Supply System.

4.7.1 **Rolling stock characteristics and train operation data.**

Traction power supply shall be designed taking into consideration the rolling stock characteristics and train operation data given below in Table 4.7.1-1 and Table 4.7.1-2.

Table 4.7.1-1

Rolling stock characteristics and train operation data

Item	Values
Maximum design speed	120 km/h
Maximum service speed	100 km/h
Adhesion	40% 30% Continuous
Acceleration 0-30 km/h for fully loaded train on tangent track	0.11 m/s^2
Service braking rate from 80 Km/h to standstill (fully loaded train on tangent track)	1.0 m/s^2 (Loco) (Indicative only)
Emergency braking rate from 80-0 km/h	1.3 m/s^2 (Loco) (Indicative only)
Type of rolling stock	Locomotive hauling flat wagons, well wagons and bulk wagons.
Type of Braking	Electro-pneumatic service friction brake, Electric regenerative brake
Design headway between trains	12minutes *
Maximum gradient	1 in 200

Note: * The headway of 12 minutes is for running of trains 6000 t/12000 t in the ratio of 2:1.

Table 4.7.1-2

Vehicle weights

Type of Vehicle	Weight
Locomotive	150 Tonnes
Bulk Wagons Loaded	6000 Tonnes (single haul)
Bulk Wagons Loaded	12000 Tonnes (double haul)

NOTE: For initial period the train will be hauled by WAG-5, WAG-7, WAG-9 locomotives of Indian Railways.

Table 4.7.1-3

Forecasted Traffic – Eastern DFC

UP Direction												
Section Name	**2016-17**			**2021-22**			**2031-32**			**2036-37**		
	Coal	Others	Total	Coal	Others	Total	Coal	Others	Total	Coal	Others	Total
Son Nagar -Mugal Sarai	47.27	19.77	67.04	54.20	27.32	81.5	65.03	48.39	113.4	69.47	63.01	132.05
Down Direction												
Section Name	**2016-17**			**2021-22**			**2031-32**			**2036-37**		
	Empties	Others	Total	Empties	Others	Total	Empties	Others	Total	Empties	Others	Total
Mugal Sarai -Son Nagar	48.52	11.06	59.58	54.23	14.70	68.93	65.47	23.43	88.90	70.70	28.77	99.47

4.7.2 **Performance Requirements of Traction Power Supply System**

a) One RSS in this project shall be equipped with two 220 kV/132 kV transformers.

b) Only TSS in this Project shall be equipped with one traction transformer.

c) Normal feeding is defined as “All traction equipment in service, with TSS supplying power upto the neutral section at the adjacent SP.”

d) Emergency Feeding is defined as “A first failure condition that either:

- Requires the bridging circuit breakers to be closed at an SP and the supply from one TSS to be extended to the circuit breakers of the adjacent TSS of DFC.
- Requires the bypass coupling interrupter to be closed between the Up and Down lines and a supply to be extended on both lines from one feeder circuit breaker as far as the adjacent SP.

e) Under all emergency feeding conditions; full designed headway service shall be feasible without any loss of performance.

f) **First failure conditions (N-1)** – Under first failure of ANY one item of equipment in the TSS, SP & SSP; full designed headway train service shall be maintained without any loss of performance.

g) **Second failure conditions (N-2)** – Under second failure conditions, the traction power systems shall allow for a reduced train service/may consider extended headway/reduced speed of trains to operate in the affected section and provision should exist with the operator to choose a combination of above or any one of the above.

h) Traction power supply system shall meet the requirements given below in Table 4.7.2-1 in respect of maximum and minimum voltages at any overhead current collection point.

Table 4.7.2-1

Voltage Requirements (Reference: IEC 60850)

Item	Value
Nominal voltage	25kVAC
Minimum Voltage	19kVAC
Maximum Voltage	27.5kVAC
Instantaneous Minimum Voltage (as specified IEC standards)	17kVAC
Instantaneous maximum Voltage	29kVAC

i) HV side normal system voltages of 132 kV and 220 kV are prevalent. Variation of +10% and -15% in the voltages are permitted as per CEA (Grid standards) Regulation 2010 (unless otherwise specifically confirmed by Utility/Regulatory Commission).

j) The design of Traction Power Supply System shall provide a voltage range of 19kV to 27.5kVAC with normal feed & one adjacent TSS out conditions with the designed headway.

4.8 Performance Features

4.8.1 The reliability of the systems designed, supplied and installed is the principal element for availability.

4.9 Service Availability Targets

4.9.1 The power supply system shall be designed to ensure that failure of any major equipment, caused by an external accident or negligence of internal staff or malicious damage by external influence, will not lead to unavailability of the whole System, other than temporary outage of the failed equipment.

4.9.2 TSS, SSP, and SP shall be designed to an availability level of N-1(First failure).

4.9.3 The traction power overhead line systems and all other associated equipment shall be designed for scheduled/routine maintenance within four hour maintenance block.

4.9.4 The electrification at Junction and Crossing stations shall permit the following:

Principles of sectioning shall permit segregation of cluster of loops and yard lines at junction stations and ensuring single line working through remote switching for cross over between UP & DN main tracks. Sectioning plan for this purpose shall be submitted by the Contractor to the Engineer for approval.

4.10 Detailed Availability Requirements

4.10.1 Circuit breakers shall be provided to operate on definite fault or over current conditions, and to isolate only the faulty part or equipment; ensuring that healthy system is not affected.

4.10.2 It shall be possible to automatically re-energize the overhead line immediately following the occurrence of transient faults such as lightning, or bird fault causing a momentary short circuit. The auto re-closure shall be of one shot only.

4.10.3 No single point failure of TSS, SP & SSP equipment shall lead to prolonged traction failure to any part of the system. Loss of any single external supply shall not affect full peak traction power being supplied to any part of the system.

4.10.4 The traction power supply shall interface with the SCADA system to allow control and monitoring remotely from the OCC. The System shall provide diagnostic information to the operator in the event of fault affecting the power supply.

4.10.5 Failures of the overhead line, or support equipment shall not cause loss of traction supply to more than one line. Provision shall be made, through sectioning switches (Interrupters) and other means, to allow reconfiguration of the traction power supply to feed the overhead line in areas; not directly affected by the fault.

4.10.6 Surge arrestors shall be with dedicated Earth pit and compatible for condition monitoring.

4.10.7 Mechanical joints of conductors, which may be susceptible to failure, shall where practicable, not be located in close proximity to locations, where there is an interface, where the public have access, e.g. Adjacent Indian Railways Stations and level crossings. Locations where the public have reasonable access may be inspected by the Engineer prior to energization of the Electrical Section.

4.10.8 Overhead line over each track on mainlines shall be supported independently and shall be robust for normal and abnormal operation. The design of supports shall be of sufficient robustness, so that an impact by a train pantograph shall not cause a failure affecting other running lines.

4.11 Maintainability

4.11.1 The Contractor shall undertake maintainability analysis to assess the preliminary maintainability targets of the systems.

4.11.2 The Contractor shall state the maintainability requirements, and demonstrate that System maintainability is sufficient to support the claimed System reliability and availability performance. The Contractor shall demonstrate that maintenance errors have been considered, and, as far as is practicable, the risk of maintenance-induced faults has been mitigated by the appropriate design.

4.11.3 Maintenance activities shall be classified into two areas- routine & preventative and corrective, both of which affect service availability. Other maintenance strategies such as condition monitoring shall be incorporated.

4.11.4 Routine/Preventive Maintenance periods shall be limited to non-operational 4 hour maintenance blocks.

4.11.5 Equipment shall be selected from a common Group of materials to ensure that equipment is interchangeable between sites, spares and training on multiple systems is kept to a minimum.

4.11.6 Where ever possible the layout of each TSS, SSP and SP shall be standard to avoid confusion and ensure interchangeability of equipment.

4.12 Safety Requirements

All safety hazards shall be mitigated at the design stage, where permissible.

a) The installation design shall incorporate measures to avoid safety hazards.

b) The Systems design shall incorporate measures to provide for its safe management and operation.

c) The Systems shall not give rise, or be subject to, dangerous interactions within the railway or with other systems. Particular attention shall be paid by the Contractor to the interface with the adjacent Indian Railways infrastructure.

d) The Traction installation shall meet the fire safety requirements as per Indian Electricity Rule & National Building Code.

e) The design of the earthing system shall conform to IS 3043: 1987 (including latest amendments) and EN 50122-1, EN 50522 and IEEE 80 etc.

- END OF CHAPTER -

5 Functional Requirements

5.1 Identification of components

5.1.1 The Receiving sub-station, Traction Power Supply Systems and OHE with control through SCADA System for Mughalsarai – New Sonnagar section and Chirailapathu (excluding New Karwandiya –Durgauti) section on the Eastern Dedicated Freight Corridor shall deliver safe, adequate and reliable traction power supply to the electric trains via overhead equipment and 240V AC supply for auxiliaries within substations, S&T installations and at all Switching Stations for hauling train loads as per table 4.7.1-2.

5.1.2 The Contractor shall prepare and submit specifications, which provide a clear description of the functional requirements of each of the system, sub-system and equipment proposed. The Contractor shall identify the manufacturer/ model and part number of each system equipment, which are planned to be installed.

5.1.3 Unless specific authorization to the contrary is given in writing by the Engineer, all design shall conform to the latest applicable standards.

- END OF CHAPTER -

6 Design Criteria & Performance Specification – General

6.1 Brief Description of the System

6.1.1 Conceptual AT system Power Supply Arrangement

Conceptual schematic power supply arrangement diagram of typical RSS/TSS/SSP/SP and preliminary system design are furnished in the Employer's drawings (list available in Annexure VII & Annexure VIII). Based on these, the Contractor may review/ improve layouts/arrangements. Conceptual drawings of Scheme of Power Supply for 2x25 kV AT system of the section, New Durgauti RSS/TSS, SP, SSP are given in Appendix A, B, C & D respectively.

6.1.2 RSS/TSS

6.1.2.1 Power supply at 220 kV will be obtained at the Receiving Sub-station. 220 kV Double Circuit Transmission line shall be constructed by **PGCIL** from its grid at Pusauli to NDGO/RSS. 220/132 kV Receiving Substation will be constructed which will supply power to TSS at 132 kV. RSS and TSS are to be erected and commissioned at NDGO in the same complex.

6.1.2.2 Provision for 2 outgoing feeders at 132 kV is to be kept for transmission line network of IR. Transmission line will be constructed in future by IR.

6.1.2.3 Receiving Substation and Traction Substation includes, but not limited to provision of:

- 220/132kV transformers (2 nos., approx. 150 MVA each) and their accessories including protection system and metering arrangement for supply of 220 kV and 132 kV to TSS and transmission network.
- 220 kV circuit breaker, TP isolator, lightning arrestor, CT, PT, protection relay, metering etc. complete with accessories.
- 132kV AC/55 kV Scott connected traction transformer complete with all accessories
- 132kV AC circuit breakers
- 132 kV TP Isolator with & without Earth Blade
- 145 kV & 42 kV Lightning Arrestor
- Double Pole 25kV circuit breakers
- Double Pole 25kV interrupters
- Single and Double pole 25kV isolators
- Autotransformers
- Circuit breaker for Auto transformer
- Auxiliary transformers
- Single core and multi core copper cables
- Return current circuit cabling
- Track Bonding
- Provision of cross track rail and its Bonding to the tracks in close coordination with Other Contractors for Civil and track works and signaling and telecommunication Contractor
- Earthing system
- Protection relays and CTs and PTs
- Metering

- Batteries and Battery Chargers
- Power Quality correction equipment for power factor, harmonics and unbalance.
- SCADA and Control equipment for RSS/TSS.
- Buried rail for traction return current.
- Fault Locator.
- All Civil and General Power Supply Works.

6.1.2.4 The outdoor switch yard of the RSS/TSS shall be covered in accordance with the guidelines of Central Board of Irrigation & Power (CBIP) for outdoor substations, Publication No. 299 “Manual on Substation Layout” and Earthing requirement in accordance with guidelines of CBIP for Earthing of AC system, publication no. 311.

6.1.3 Sectioning and paralleling Posts (SP)

6.1.3.1 Section Post includes, but not limited to provision of:

- Double pole 25kV interrupters
- Double Pole 25kV isolators
- 25 kV Double Pole Circuit Breaker
- Autotransformers
- Circuit breakers for Auto transformers
- Auxiliary Transformers
- 27.5 kV/110 V Potential Transformer Type-I/II/III(as per requirement)
- Single core and multi core copper cables
- Return Current Circuit Cabling
- Track Bonding
- Earthing system
- Interlocking PLC
- Batteries and Chargers
- SCADA and Control equipment
- 42 kV Lightning Arrestor
- Relay and Protection panel
- All Civil and General Power Supply Works.

6.1.4 Sub Sectioning and paralleling Posts (SSP)

6.1.4.1 Sub-Section Post includes, but not limited to provision of:

- Double Pole 25kV interrupters
- Double Pole 25kV isolators
- Autotransformers
- Circuit breakers for Auto transformers.
- Auxiliary Transformers
- 27.5 kV/110 V Potential Transformer Type-I/II/III(as per requirement)

- 42 kV Lighting Arrestors
- Single core and multi core copper cables
- Return Current Circuit Cabling
- Track Bonding
- Earthing system
- Interlocking PLC
- Batteries and Battery Chargers
- SCADA and Control equipment
- All Civil and General Power Supply Works.

6.2 Conceptual Traction Overhead Equipment Arrangement

6.2.1 The Contractor shall provide 25kV AT feeding overhead equipment on main lines.

6.2.2 A 25kV conventional overheads line equipment shall be provided on all loops and stabling lines at Junction and Crossing Stations. The conductor type, size and tension are to be kept the same as main line.

6.2.3 The nominal height of contact wire shall be 5.6m above rail level.

6.3 Design of the Power Supply System

6.3.1 Anticipated short circuit levels shall be as indicated in Table 6.5.2-1. Based on the traction power system requirements and fault analysis, the power supply system shall be designed & ratings of all equipment, cables of different voltages 25kV and 240V, AC Auxiliary supply, Earth bus and conductors, joints, jumpers, as well as ancillary equipment and instrument transformers shall be firmed up. The details of calculations and specifications finalized shall be submitted for review and approval of the Engineer.

6.3.2 To specify the optimum interval between rail to Earth connections to ensure that the rail voltages are within permissible limits as per IEC 62128-1.

6.3.3 The TSS shall be provided with one traction transformer. The layout should be designed in such a way so that the second traction transformer can be installed easily in future.

6.3.4 The specification gives indicative details of power supply arrangements envisaged for traction supply for Dedicated Freight Corridor. The Contractor is expected to examine the entire scope of work and scrutinize the specified system, and work out the ratings based on his own designs of the entire system.

6.3.5 The design of power supply system shall be for nominal frequency of 50Hz $\pm$3%.

6.3.6 In the event that a feeder circuit breaker fails at a TSS, it shall be possible to resume supply by closing an interrupter to parallel the up and down lines together through another feeder circuit breaker.

6.4 Design of Earth System

6.4.1 System protective earthing for providing electrical safety on entire system including earthing of non-current carrying metallic components, cable supports, transformer neutrals, lightning arrestors, etc. shall be designed. The Earth system shall consist of:

a) Earth Mat and Earthing Systems in Traction Substations and Receiving Substation.

b) Earth System in Sub-Sectioning and Paralleling Posts.

c) Earth System in Sectioning and Paralleling Post.

d) Earth Conductors to Earth Over Head Equipment system.

e) Earthing and bonding of adjacent metallic structure.

f) Buried Earth Conductor at suitable depth, if required.

6.4.2 The Earth Mat / Earth electrodes shall be provided by the Contractor. The design shall conform to IEEE-80:2013.

6.4.3 The Contractor shall carry out entire design study of the earthing system on the basis of safety to public, the operator and maintenance Personnel against touch and step potential and fire hazards and finalize the design, sizes and layout of main Earth conductors, taking into account adjacent 25 kV systems. The contractor shall also study the requirement of mitigation measures on Indian Railways running parallel to DFCCIL and submit a detailed report to Engineer for approval. The employer shall decide the agency through which such measures are to be taken up.

6.4.4 In all traction power supply control posts, GI Flats and pipes, allowing adequate margin against corrosion shall be used as per EN-50522 and Manual on Earthing of AC Power Systems issued by Central Board of Irrigation and Power. The Earth rods shall be copper clad steel as per IEEE-80/IEC-62561-2/ANSI/NEEMA Gr.-I-2007/EN50522-2. Materials should be UL listed, wherever applicable.

6.4.5 **Lightning Protection System:**

6.4.5.1 The entire substation shall be protected against lightning strikes by providing earth screen conductors on tower peaks &/or by means of lightning protection masts suitably spaced to cover the entire area.

6.4.5.2 The height & locations of the lightning mast shall be designed appropriately with due consideration of the equipment layout in the switching stations, to ensure that all the equipment required to be protected against lightning are within protective zone provided by the lightning conductor.

6.4.5.3 The lightning conductor shall consist of:

(a) Lightning receiver projecting above the object to be protected.

(b) The earthing grid.

(c) The conductor which connects the receiver with the earthing grid & is meant to carry the lightning current away safely to ground.

6.4.5.4 The contractor shall furnish a calculation for the direct stroke lightning protection system for RSS/TSS/SSP/SP & ensure that all the equipment remain protected from direct stroke lightning. The lightning protection design shall provide a failsafe protection to the control building & switchyard of RSS/TSS/SP/SSPs.

6.4.5.5 Lightning protection shall conform to IEEE-998, IEC-62305 & IEC-62561 as applicable.

Table 6.4-1 Maximum Earth Resistance

Location	Earth resistance (ohms)	
	Each electrode	Total Earth system
RSS	5	0.5
TSS	5	0.5
SSP	5	2.0
SP	5	2.0
Other locations	10	To meet the requirements of EN 50122-1

6.5 Short Circuit Capacity

6.5.1 The Contractor shall ensure that traction and substation auxiliary power supply system including cables installed shall be capable of withstanding the Power Utilities fault levels at the points of common coupling and downstream with an allowance to cater for possible future increases.

6.5.2 The fault levels to be catered for are given in Table 6.5.2-1 below. Specific requirements (if they are different) are furnished in the equipment/sub-system specifications.

Table 6.5.2-1 Design Short Circuit Levels

System Voltage (kV)	Breaking Capacity in MVA	Fault Current in kA	Fault Duration in Seconds
220	20000	40	1
132	10000	30	1
25	30	12	3

6.5.3 Higher Fault levels can be expected for TSS locations vary close to generating station for which actual fault levels may be worked out and switch gear selected accordingly.

6.6 Insulation Coordination

6.6.1 The nominal voltages and corresponding maximum voltages shall be as follows:

Nominal Voltage	Maximum Voltage
230V	250V
25kV	29 kV
132kV	145kV
220kV	245kV

6.6.2 The 220 kV/AC 132kV/AC, 25kV AC and 230V equipment shall meet the insulation coordination requirements of IS 2165 (Part I and Part II) with latest amendments.

6.6.3 25 kV AC equipment shall have insulation levels according to the EN 50124, Railway Applications-insulation coordination.

6.6.4 2x25 kV switch gears where the supply phases are 180 Degree apart, the rated voltage will be minimum 60 kV.

6.6.5 Plug and socket arrangement for connection of control circuits shall be used for reliability and ease of maintenance. It shall have suitable locking arrangement.

6.7 Switchgear and panels

6.7.1 All switchgear and panels shall be vermin proof, constructed from mild steel finished with anti-corrosion paint. Protection Class at a minimum shall be IP 54.

6.7.2 The switchgear shall be designed such that failed equipment can be changed and replaced within 4 hour maintenance period.

6.7.3 Switchgear shall have appropriate terminations to suit the locations and electrical clearances. Where the size of available land is small, the Contractor shall use cable box terminations to maximize the electrical clearances to the operational railway.

6.8 Protection Scheme

6.8.1 The Contractor shall define the philosophy and furnish a scheme of protection with fast discrimination and reliable operation based on latest state-of-the-art computerized logic protection scheme. All types of faults in RSS, TSS and on Overhead Equipment covering Faults among Conductors for 25kV (a degree of accuracy within 200 m (3 span length)) Feeder, OHE, and Earth shall be identified and location of fault to facilitate isolation.

6.8.2 The scheme of protection shall be fully coordinated with the Power Utilities/PGCIL.

6.8.3 The Contractor shall submit detailed fault calculations, relay settings and fault coordinated curves showing proper protection, discrimination between all upstream and downstream equipment. Detailed protection system shall be submitted for approval of Engineer.

6.8.4 All protection functions available in the manufactures specification shall be available for use of the Employer, without having to purchase any passwords or unlocking codes. Any such passwords or unlock codes shall be available to the Employer free of cost during and post contract.

6.8.5 All the relays employed for protection of the system shall be numerical type confirming to IEC- 60255 or RDSO specification, wherever applicable.

6.9 Galvanisation of all Outdoor Steel Works

6.9.1 Steel structures for outdoor RSS, TSS, SSP and SP and those required for support of overhead equipment, all Small Part Steel works (SPS) shall be hot dip galvanized as per RDSO's specification No.ETI/OHE/13 (4/84) or latest.

6.9.2 The galvanization shall be done only after cutting and drilling work is over. Galvanized bolts, nuts and spring washers shall be used for assembly work.

6.9.3 Wherever galvanizing on ferrous components has been damaged in handling, the same shall be given two coats of zinc chromate primer and two coats of aluminum paints conforming to IS 2339.

6.10 Electromagnetic Compatibility (EMC) Requirements

6.10.1 General

6.10.1.1 The EMC Control Plan shall include measures to reduce conducted, induced and radiated emissions, especially the levels of harmonic, to acceptable values as specified by the relevant International Standards.

6.10.1.2 The plan shall analyze EMI/EMC impacts on the design of the train, all other train-borne equipment and trackside equipment as well as the general environment. Particular attention shall be paid to additional requirements in grounding, Bonding, Shielding, Filtering, and Cabling arrangements.

6.10.1.3 The Contractor shall identify all EMC tests to be undertaken in the EMC Control Plan and the where appropriate in the integration testing plan. The test plan shall make clear the pass / fail criteria prior to any testing taking place.

6.10.2 Intra-System EMC

6.10.2.1 The Contractor shall ensure that all intra-system EMI are taken care of through proper design and other special measures. All major sub-systems shall be tested for emissions and immunities in accordance with the appropriate International Standards for equipment operating in railway or similar industrial environment.

6.10.3 Inter-System EMC

6.10.3.1 The Contractor shall ensure that all equipment are designed and constructed in accordance with the latest issues or versions of internationally recognized EMC standards.

6.10.3.2 The Contractor shall also provide computations on the expected conducted and radiated emissions from the power supply system due to electrical fault, load fluctuations, and/or system imbalance. Their effects on the safety-related equipment, especially the probabilities of leading to an unsafe operation shall be determined. An appropriate technical document for safety audit shall be maintained by the contractor to demonstrate EMC compliance.

6.10.4 Non-Safety-Related Systems Interference

6.10.4.1 The Contractor shall take appropriate measures to ensure that EMC is achieved between the power supply equipment and all other system equipment. The transformer shall be designed with particular attention to the suppression of harmonic voltages, especially the third and fifth or any other values as specified by the latest version of the EN 50121 and other relevant International Standards.

6.10.4.2 All radiated emissions, either via the power cables, transformers or any other system components, shall be minimized such that they conform to the appropriate International Standards. Special reference shall be made to the compliance of EN 50121-5, EN 50152, and IEC61000-2.

6.10.4.3 All power cables shall be properly shielded where applicable. Reference shall be made to IEC 61000-4-6 and IEC 61000-4-16.

6.10.4.4 The Contractor shall also co-ordinate with other contractors whose equipment are connected to the power supply system and are likely to inject unwanted emissions into the power supply system to reduce such emissions. Reference shall be made to EN 50121-2, EN 50121-4, EN 50121-5, IEC 61000-3 and IEC 61000-4-7.

6.10.5 Environment EMC

6.10.5.1 The Contractor shall ensure that radiated emissions from the power supply cable are maintained at an internationally acceptable level. The Contractor shall also ensure that the power cables are protected from RF radiations from all telephone network operators and radio networks.

6.10.6 Installation and Mitigation Guidelines

IEC61000-5 series of guidelines shall be observed; wherever applicable.

6.10.7 Earthing and Bonding

6.10.7.1 The contractor shall design earthing and bonding arrangement for OHE through computer based simulation. Rail accessible and touch potential within safe limits under normal and fault conditions including configuring earthing and bonding for the entire system (including those on adjacent structure), determination of sizes / intervals of interconnection between AEW & BEC and their connection of mast/earth-station and rail without any compromise in safety of public/Railway maintenance personal even in case of OHE Short Circuit Fault while on going discontinuity in rail track system due to hair crack (s) as well as discontinuity in AEW.

6.10.7.2 The Contractor shall develop Earthing and Bonding Plans covering all the buildings, structures and adjacent Indian Railway tracks or any other Utilities or metallic structures in proximity belonging to other independent authorities to provide protective provisions against EMI from 25kV traction currents and to limit touch potentials as a result of Simulation study so as to provide a safe environment. In case of any modification required for existing Indian Railways Track, the Employer shall decide the agency through which such measures are to be taken up.

6.10.7.3 The Contractor shall prepare an Earthing & Bonding Management Plan and submit it for the approval of Engineer. This plan shall apply to the Permanent Works by all the Other Contractors on the Project to ensure the structures and equipment are safe from EMI due to 25kV traction effects Touch Voltages and shall be an important interface requirement for the Project. The touch voltages shall not exceed the value for short time & long term condition for back up protection values indicated in Table 3 & 4 of EN 50122-1 for 300 milisec.

6.10.7.4 The earthing system shall be designed to ensure Personnel safety and protection of persons and installations against damage and shall also serve as a common voltage reference and to contribute to the mitigation of disturbances

6.10.8 Bonding

6.10.8.1 Bonding of all exposed metallic parts of all equipments and connecting them to the earthing is required.

6.10.8.2 Direct Bonding shall be used, wherever practical. Where indirect Bonding via Bonding strap is used to connect two isolated items, the bond shall satisfy the following minimum requirements and prevailing International Standards, for example, IEC 61000-5-2 and EN 50122-1.

a) Low Bonding resistance from DC to at least 2 GHz.
b) Low Bonding inductance from DC to at least 2 GHz.
c) Proper Bonding procedure, including appropriate surface treatment before and after the Bonding process, is adopted.
d) Proper use of bond material to minimize electrolytic corrosion.

6.10.9 Cabling

6.10.9.1 The cables used shall be adequately protected against external interference. Additional protective measures, including but not limited to the use of metallic conduit, armour, screening conductors, ferrite choke and EMI filters shall be used to reduce such external interference, wherever required.

6.10.9.2 A cable routing plan shall be designed to minimize likelihood of coupling between parallel cables. The Contractor shall refer to guidelines recommended by IEC61000-5-2.

Table 6.11.9-1

Immunity levels at various power ports

Enclosure port	
Test	**Severity level**
RF field	800-1000 MHz, 20 V/m, 80%AM 1kHz
RF field - pulse modulated	900 MHz, 20 V/m, 50% duty cycle, PRF 200 Hz
Power frequency magnetic field	50 Hz, 100 A/m
Electrostatic discharge	6kV contact, 8kV air
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHzsource impedance 150 ohms
Fast transients	2kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Port for process, measurement & control lines, and long bus & control lines	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHz source impedance 150 ohms
Fast transients	4kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	1.2/50 Tr/Th sec, 2 KV (c), 1kV (d)
Power frequency	150 V rms
Power frequency common mode	650 V rms

DC input and DC output power ports	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1KHz source impedance 150 ohms
Fast transients	4kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	1.2/50 Tr/Th sec, 2kV (c), 1kV (d)
AC input and AC output ports	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHz source impedance 150 ohms
Fast transients	4kV, 5/50 Tr/Th nanoseconds, PRF 5 kHz
Transients common/diff modes	2/50 Tr/Th sec, 2kV (c), 1kV (d)
Earth port	
Test	**Severity level**
RF common mode	0.15-80 MHz, 20 V, 80%AM at 1kHzsource impedance 150 ohms

6.10.9.3 Proper Bonding & cross Bonding of metallic conduits armour& screening conductor shall be made to ensure that the induced voltage is within safe limits.

6.10.9.4 25kV AC single core cables shall be insulated with XLPE and shall be armored. The outer sheath of the cables shall be able to protect against ultra violet radiation.

- END OF CHAPTER -

7 Design Criteria and Performance Specification – Traction Power System

7.1 Scope of Works

7.1.1 System Wide - Scope of Works includes following installations: One Receiving Substation (RSS) cum Traction Sub-Station (TSS), One Section Posts (SP) and Three Sub Section Posts (SSPs).

7.1.2 Land has been acquired for RSS, TSS, SP and SSP as shown in the table 7.1.3-1, 7.1.3-2 & 7.1.3-3.

Table 7.1.3-1

List of Proposed Traction Substations (TSS)/RSS
[Tentative Size of Land 170 x 100 m^2]

Nos.	RSS/TSS Name	IR Chainage (approx.)	Section	DFC Chainage (approx.)
1	New Durgauti RSS/TSS	624/20-24	SEBN-MGS	74.60

TSS at Karwandiya (IR Chainage 566) with Double traction transformer is going to be commissioned shortly. TSS at Deoria (IR Chainage 681) with Double traction transformer is going to be commissioned shortly.

Table 7.1.3-2

List of Proposed Sectioning Post (SP)
Tentative Size of Land for SP (55m x 30m)

No.	SP Name	IR Chainage (approx.)	Section	DFC Chainage (approx.)
1	New Chandauli	655/10-8	SEBN - MGS	105.200

Table 7.1.3-3

List of Proposed Sub Section Posts (SSP)

Tentative Sizes of Land for SSP (55m x 25m)

Nos.	SSP Name	IR Chainage (km) (approx.)	DFC Chainage (km) (approx.)	DFC Section
1	New Sonnagar	548/2-6	2.2	SEBN-MGS
2	New Karmnasa	640/16-18	90.35	SEBN-MGS
3	New Ganjkhwaja	668/1A	117.85	SEBN-MGS

a) For each SP location, there is a need to review the location of Neutral section. Location opposite SP is appropriate for passage of trains (single trains with locomotive and also two coupled trains with two locomotives located 750m apart, that the traction demand on adjoining TSS are approximately balanced to enable

uniform capacity of Traction Transformers to be used on the route. Neutral section will also have to be located on a suitable spot in relation to the adjacent automatic stop signals and also the terrain shall be such that the trains coast through; without risk of stalling in the neutral section zone.

7.1.3 In regard to SSPs, their locations are primarily chosen to enable appropriate Sectioning, so as to permit trains to take alternative paths through stations during traffic and power blocks minimizing traffic delays.

7.2 Equipment, their specification & ratings

7.2.1 Based upon the indicative Scheme of power supply of Mughalsarai– New Sonnagar and Chirailapathu (excluding New Karwandiya to Durgauti) Conceptual drawings of Scheme of Power Supply for RSS/TSS, SP, SSP are given in Appendix A, B, C & D respectively. Contractor shall verify the details and prepare his own General Supply Diagram, Sectioning Diagram and layout. The RDSO Drawings and specifications of the major equipments are given in Annexure VI and Annexure VII respectively.

7.2.2 Traction Transformers

Table 7.2.2

Salient Features of 132/55 kV Traction Transformers

Parameter	Rating
Power Rating	60/84/100 MVA(Minimum)
Cooling	ONAN/ONAF/OFAF
Connection type	Scott Connected
Number of secondary windings	Two, Main and teaser
Rated secondary voltage	55kV
Rated secondary current	556/ 778/926 A (for each secondary winding)
Phase difference between main and teaser windings	90^o
Rated Primary voltage Un	132kV
Percentage Impedance at 60 MVA	11%
Non-cumulative overload capacity after the transformer has reached steady temperature on continuous operation at rated power.	150% rated load for 15 min 200% rated load for 5 min

7.2.2.1 The transformers shall be designed so that they can be delivered by rail as well as road. The transformer shall be designed such that it is within IR SOD and DFCC-SSOD 2013 for Eastern Corridor. Radiators, accessories and conservators may be removed for transport. The insulation oil may be removed for transport and a nitrogen cushion employed during transportation.

Further, the design shall incorporate provision of ONAF and OFAF cooling at a later stage, when load increases up to 84 MVA and 100 MVA respectively. All the cable works for control and monitoring of the fans and pumps shall be done initially. The fan motor and the pump motor shall be operated on single phase ac supply at 230V. Initially, transformer shall be supplied with ONAN cooling arrangement. Fans & Cooling pump and accessories shall be provided by the Employer in future. However,

complete details of fan and cooling pump is to be furnished along with associated arrangement.

7.2.2.2 The transformer shall be installed on a suitable foundation that can withstand the transformer static and dynamic load. The foundation shall be able to support the loads during installation and removal. The foundation for stand by traction transformer should also be constructed for installation in future.

7.2.2.3 The substation transformer bays shall be provided with suitable pulling eyes to allow the transformer to be moved on rails and positioned.

7.2.2.4 Each transformer shall be located in its own bund (liquid containment). The bund shall contain stone metal soaking pits with voids of capacity adequate to contain at least 110% of total quantity of oil. Bund for standby traction transformer should also be constructed.

7.2.2.5 If there is a requirement to store spare transformer oil at the TSS, the oil drums shall be stored on their own bund to prevent spillage. The bunds used for oil storage barrels shall be positioned so that they do not fill with rain water.

7.2.2.6 There shall be a baffle wall between adjacent transformers. The wall shall be sufficient to protect adjacent transformers in the event of a catastrophic failure of one of the traction transformers.

7.2.2.7 In urban areas, the traction transformer shall be enclosed in acoustic barriers where the operational noise contravenes the requirements of the “The Noise Pollution Regulation and Control) Rules, 2000 or later”.

7.2.2.8 The design of the substation shall be such that one transformer can be removed by road or rail without disturbing the operation of the railway and allowing the remaining transformer to continue to supply the railway and operate a full headway service.

7.2.2.9 The safety provision shall comply with section-44 of Central Electricity Authority regulation-2010 (Measure relating to safety & electrical supply)”. The Traction Transformer shall be provided with Nitrogen Injection Fire Suppression system. Fire load / Nitrogen volume with rate of flow shall be calculated to ascertain adequacy of gas to quench the possible fire.

7.2.2.10 The full load efficiency of the transformer shall be same (as 60/84/100 MVA) or better if higher rating is offered by the bidder.

7.2.2.11 Traction transformer shall be manufactured and supplied as per details furnished in Vol 9, PS (Electrical) Annexure XIII.

7.2.3 Power transformer

Table 7.2.3

Salient Features of 220/132kV Power Transformers

Parameter	Rating
Power Rating	75/105/150MVA (Minimum)
Cooling	ONAN/ONAF/OFAF
Rated Primary Voltage	220kV
Rated secondary voltage	132kV
Rated secondary current	328/459/656 A
System Frequency (Hz)	50

Parameter	Rating
Impedances (%)	10
Tapping range	-5 to +15% 16 equal steps each 1.25% on LV
Type of tap changer	OFF Load, can be operated from OCC
Overload capacity	As per IS:6600-1972/ IEC354
Suitable for parallel operation	Yes

7.2.3.1 The transformers shall be designed so that they can be delivered by rail as well as road. The transformer shall be designed such that it is within IR SOD and DFCC-SSOD 2013 for Eastern Corridor. Radiators, accessories and conservators may be removed for transport. The insulation oil may be removed for transport and a nitrogen cushion employed during transportation.

Further, the design shall incorporate provision of ONAF and OFAF cooling at a later stage, when load increases upto105 MVA and 150 MVA respectively. All the cable works for control and monitoring of the fans and pumps shall be done initially. The fan motor and the pump motor shall be operated on single phase ac supply at 230V. Initially, transformer shall be supplied with ONAF cooling arrangement. Cooling pump and accessories shall be provided by the Employer in future. However, complete details of cooling pump is to be furnished along with associated arrangement.

7.2.3.2 The transformer shall be installed on a suitable foundation that can withstand the transformer static and dynamic load. The foundation shall be able to support the loads during installation and removal.

7.2.3.3 The substation transformer bays shall be provided with suitable pulling eyes to allow the transformer to be moved on rails and positioned.

7.2.3.4 Each transformer shall be located in its own bund (liquid containment). The bund shall contain stone metal soaking pits with voids of capacity adequate to contain at least 110% of total quantity of oil.

7.2.3.5 If there is a requirement to store spare transformer oil at the RSS, the oil drums shall be stored on their own bund to prevent spillage. The bunds used for oil storage barrels shall be positioned so that they do not fill with rain water.

7.2.3.6 There shall be a baffle wall between adjacent transformers. The wall shall be sufficient to protect adjacent transformers in the event of a catastrophic failure of one of the transformers.

7.2.3.7 In urban areas, the transformer shall be enclosed in acoustic barriers where the operational noise contravenes the requirements of the “The Noise Pollution Regulation and Control) Rules, 2000 or later”.

7.2.3.8 The design of the substation shall be such that one transformer can be removed by road or rail without disturbing the operation of the railway and allowing the remaining transformer to continue to supply the railway and operate a full headway service.

7.2.3.9 The safety provision shall comply with section-44 of Central Electricity Authority regulation-2010 (Measure relating to safety & electrical supply)”. The Transformers shall be provided with Nitrogen Injection Fire Suppression system. Fire load / Nitrogen volume with rate of flow shall be calculated to ascertain adequacy of gas to quench the possible fire.

7.2.3.10 The full load efficiency of the transformer shall be same (as 75 MVA ONAN) or better if higher rating is offered by the bidder.

7.2.3.11 RDSO specification TI/SPC/PSI/AUTOTR/0090 (12/09) for 50/75/150 MVA, 220/132 kV 3phase oil immersed type Power transformer may be studied for guidance and detailed specification may be prepared incorporating parameters mentioned in Table 7.2.3 and submitted to Engineer for approval.

7.2.4 Autotransformer

7.2.4.1 Specification for 8 MVA autotransformer is furnished in annexure XIV of Vol. 9 (PS Electrical). The specification may be studied for guidance and detailed specification may be prepared incorporating parameters mentioned in Table 7.2.4-1 and submitted to Engineer for approval. The ratings of Autotransformer shall be as under:

Table 7.2.4-1

Salient Features of Autotransformers

Parameter	**Rating**
Power Rating	12 MVA
Cooling	ONAN
Rated secondary voltage	55kV
Rated secondary current	444A
Rated Primary voltage Un	27kV
Non-cumulative overload capacity after the transformer has reached steady temperature on continuous operation at rated power.	150% rated load for 15 min 200% rated load for 5 min
Short Circuit Capacity	35 times for TSS 25 times for SP/SSP

7.2.4.2 The safety provision shall comply with section - 44 and other relevant sections of Central Electricity Regulation – 2010 or as revised (on measures relating to safety and electricity supply). The Auto Transformers shall be provided with Nitrogen Injection Fire Suppression system. Fire load / Nitrogen volume with rate of flow shall be calculated to ascertain adequacy of gas to quench the possible fire.

7.2.5 25kV Double Pole Circuit breakers

7.2.5.1 The command and control signals shall enter the enclosure via pressure tight plug and sockets to provide simple and quick connection and disconnection.

7.2.5.2 The poles shall be able to be operated locally, electrically or by a control handle manually from the local control cabinet.

7.2.5.3 25kV circuit breaker shall be vacuum type.

7.2.5.4 The circuit breaker shall have the minimum of 3 normally open and 3 normally closed auxiliary contacts that are directly driven from the parts of the circuit breaker / interrupter.

7.2.5.5 The control panel shall be suitable for operating with the door open during inclement weather as indicated in the climatic and atmospheric conditions stated in this document in Annexure III.

7.2.5.6 The control cabinet shall be equipped with the following functions:-

- Local and remote operation switch

- Open and Close buttons
- Open and Closed indications
- Operations counter.
- Control indication monitor
- Capacitor charge indicator

7.2.6 Surge Arresters

7.2.6.1 Surge arresters shall be installed at each locations of RSS, TSS and the Switching posts.

7.2.6.2 Surge arresters shall be of gapless type with counter and health indicator installed.

7.2.6.3 Each surge arrester shall incorporate an individual Earth which shall be connected to a ground rod or rods and shall also be connected to the Earth system in vicinity.

7.2.6.4 Each Earth connection shall have Earth resistance as specified by the surge arrester manufacturer for the type of unit supplied, and shall be tested individually in accordance with testing procedures specified under an appropriate International Standard.

7.2.6.5 Bonding cable connections between the surge arrester and the OHE, and between the surge arrester and the grounding system, shall be installed with a minimum number of bends.

7.2.6.6 The connection of Surge Arresters to OHE shall be such that in case of breakage of the Surge Arrester, the connector does not create an Earth fault in the OHE. Connection with Earth to be compatible with contact less condition monitoring of surge arrestors.

7.2.7 Batteries and Chargers

7.2.7.1 There shall be two battery chargers for TSS. There shall be two separate battery chargers for RSS also.

7.2.7.2 Each battery charger shall be capable of supporting the total substation 110V DC operational load.

7.2.7.3 The substation batteries shall support the 110V DC loads for a minimum of 10 hours following 230V, AC, power or failure of all battery chargers.

7.2.7.4 The 110V battery charger shall be fed from the Essential Services distribution board that itself will be fed from substation Auxiliary transformers.

7.2.7.5 The battery charger shall be located inside a water tight, environmentally controlled structure.

7.2.7.6 All equipment shall have at least two readily accessible separate Earth terminals, which shall be identified by symbol of Earth mark adjacent to the terminals.

7.2.8 Control and Power Cables

7.2.8.1 The run of various cables shall be designed so as to ensure minimum de-rating.

7.2.8.2 Power and Control cables shall be installed in separate cable containments.

7.2.8.3 All cable shall be suitable as per the climatic & atmospheric conditions given in Annexure-III of this document. Where cables are installed in trenches or ducts the cable shall be designed to function without any deterioration in fully immersed in water or insulation oil.

7.2.8.4 Cabling & ducting shall be designed and supplied to be vermin proof.

7.2.8.5 Cables shall be indelibly marked along their whole length with the following information as a minimum:

- Manufactures name
- Insulation material
- Number of cores
- Cable conductor size
- Cable nominal voltage
- Batch no.
- Year of manufacture
- Country of origin

7.2.8.6 Cable joints shall not be formed in ducts or trenches. Where joints are needed in duct or trenches separate joint bays shall be constructed.

7.2.8.7 All cables and ducts shall have identification plates fitted at the following locations as a minimum:

- At all terminations.
- Every 100m along the length.
- At entries/exits through walls or obstructions.
- Entry and exits to ducts or trenches
- At cable joints

7.2.8.8 All cable joints shall be allocated cable joint numbers and each joint shall be physically labeled. The location and joint numbers shall be shown on the as built record drawings.

7.2.8.9 The cable design and installation shall meet the regulations of IEEE and fire safety regulations of National Building Code.

7.2.9 Design Criteria for Power Quality Improvement

The Contractor shall employ suitable fixed and variable capacitor bank for power quality improvement measures using shunt capacitor bank, filters for harmonic resonance suppression circuits, technique to achieve power with more than 0.95 power factor as per latest RDSO specification.

Assuming an Initial demand of 30MVA, the Contractor shall install power factor correction device to improve power factor from 0.85 to 0.95 by installing 50 % static and 50 % variable capacitors or 100% Variable capacitors (without permitting to go in leading power factor) capable of up-gradation when full load of 60/84/100MVA materialises in future.

For calculation, the designer shall assume 80% of conventional locomotives (WAG-5, WAG-7) with average power factor of 0.7 and 20% locomotive of WAG-9 or high horse power locomotive with average power factor of 0.95.

7.2.9.1 Power Quality

7.2.9.2 Contractor shall ensure the Power Quality keeping the voltage and current unbalance, receive power and harmonic contents within the prescribed limit of state utility in normal and extended feed conditions throughout the designed life of the equipment. For connectivity to the grid sub-station of power supply authorities, following power quality limits have been laid down at the point of common coupling (PCC), the contractor shall Control the power quality within the applicable limits by providing the necessary PQ Improvement equipment.

7.2.9.3 **Voltage Unbalance**

The limit of voltage unbalance permitted according to Central Electricity Authority (CEA) standards are as follows:

Voltage of Supply	Maximum permissible unbalance
132 kV	3%
220 kV	2%

7.2.9.4 **Harmonic Generated at the PCC-132kV & 220kV**

The contractor shall carry out the Harmonic Study and provide the Mitigation equipment to limit the Harmonic within prescribed limits as per guidelines issued by Central Electricity Authority (CEA) of India as given in table below.

Harmonic Generated	**132kv system**	**220kv system**
THD for voltage	Not more than 5%	Not more than 2.5%
Any individual harmonic	Not more than 3%	Not more than 2%
THD for current	Not more than 8%	As per IEEE STD-519:1992

7.2.9.5 The design of 12000 HP locomotives is planned to limit the harmonic specified in the table below for stages of operation of 100 % down to 50 % working in a train. However for the existing locomotives on IR harmonic measurement shall be carried out for the purpose of design.

SN	**Interference current**	**Limit**
1	Psophometric current	10.0 A
2	DC component	4.7 A
3	Second Harmonic Component (100 Hz) and 88.33 Hz component.	8.5 A
4	1400 Hz to 5000 Hz	400 A

7.2.9.6 The contractor shall study electricity Grid Supply Code and electricity supply code issued by CEA and tariff order issued by Regulatory Commission. The contractor shall prepare a detailed document on power quality and obtain prior approval of the same from Engineer.

7.2.10 Design Criteria for Protection

The Contractor shall supply the protection system as per RDSO Spec no. TI/SPC/PSI/PROTCT/7100. (Technical specification for control and relay panel including numerical type protection relays for Scott-connected/single phase traction transformers, OHE protection and shunt capacitor bank protection for 2x25kV traction sub-station).

In addition to above, Auto transformer will also be protected. To isolate faulty auto-transformers, each auto-transformer will be automatically disconnected through Circuit breakers across the auto transformer as per IE rule and approved protection scheme. All the Circuit breakers provided for Auto Transformers at TSS/SSP/SP shall be with double pole isolators to facilitate its maintenance. It shall be possible

to isolate the faulty auto Transformer as well the section fed remotely through SCADA.

Protection scheme for 220kV/132kV RSS should be based on principles followed by PGCIL following latest IE rule. The protection scheme should be approved by the engineer.

7.2.11 Design Criteria for SCADA

The SCADA system is to be designed, supplied and commissioned by the RDSO approved vendor. The system contractor will submit the relevant documents to Engineer and take his approval in this regard. All matters related to design, supply, inspection, installation and testing will be done by the competent representative of approved SCADA sub contractor.

The Contractor shall study the RDSO specification no. TI/SPC/RCC/SCAD/0130 (rev.2) (Revised in July, 2016) or latest for IP based SCADA system as per IEC 60870-5-104 and propose the SCADA system for this contract covering the basic architecture to be followed and corresponding communication protocol to be adopted. The system shall be developed based on report of system and functional requirement of SCADA and protection study report duly approved.

In addition to above, SCADA system should cover Sectioning Switches (Interrupters) provided for sectioning of main line and motorized isolator provided at yard and loop line.

The SCADA arrangement for the section is to be integrated/Upgraded/modified with the existing SCADA arrangement of DGO-NKWD section and is to be commissioned at OCC Allahabad. Presently the SCADA arrangement of DGO-NKWD is at RCC/Mughalsarai and is likely to be commissioned shortly. The contractor should study the field equipment provided in DGO-NKWD section for compatibility.

Further, SCADA system and protection system should cover RSS/New Durgauti and 132 kV outgoing feeder arrangement alongwith above details.

The system contractor shall display SCADA information on video wall provided by him at OCC/Allahabad. Video wall is covered in volume-8: PS/Telecommunication work.

The SCADA system shall be integrated with fire control system to notify SCADA Operator for any untoward fire situation at traction power supplies installation.

The video Surveillance system shall be provided for effective real-time video surveillance of the Receiving/ Traction Substation from OCC. The specifications for these items are covered in the volume-8: Particular specification for Telecommunication Work of the bid document. Traction Power Controller (TPC at OCC control room) shall be provided with one additional Client PC workstation with 21 Inch full HD LED backlit colour monitor for viewing, monitoring and management of Video Surveillance Data.

SCADA should also have arrangement for monitoring Battery Charger and LA counter at RSS/TSS/SP/SSP.

Additionally, the SCADA system shall include a data link to a maintenance management system (MMS being developed by DFCCIL). This link shall enable the SCADA System to forward fault information to the MMS from all connected equipment to identity the location and nature of faults.

7.2.12 Design Criteria for Fault Locator

The Contractor shall submit the performance specification of fault locator proposed to be offered for this contract to the Engineer for approval along with its accuracy and its use elsewhere to have satisfactorily functioned. It must have proper interface with SCADA.

7.2.13 For RSS/TSS/SP/SSP: Contractor shall submit for approval the following drawings:

a) Cross section drawings.

b) General arrangement drawings.

c) Structural drawings.

d) Foundation lay out and cross section drawings.

e) Earthing layout drawings.

f) Cabling & wiring drawings.

g) Fencing layout drawings.

h) Equipment drawings with drawing of component parts.

i) General drawings.

7.2.14 Interface for Transmission line and RSS:

Item	**Will be done by**
220 kV double circuit transmission line Pusauli to New Durgauti	PGCIL
Gantry 220 kV	System Contractor
RSS 220/132 kV	System Contractor
Connection to transmission line at 220 kV	PGCIL
TSS 132 kV/55 kV	System contractor
LILO arrangement 132 kV	System contractor
Gantry 132 kV	System Contractor
Connection to IR Transmission line at 132 kV	IR

The system contractor shall co-ordinate with PGCIL for completion of the work.

- END OF CHAPTER -

8 Design Criteria and Performance Specifications - Flexible Overhead Contact System (OHE)

8.1 General Requirements

8.1.1 Scope of Work

This specification covers complete design, supply, installation, testing and commissioning of Traction Overhead Equipment (OHE) for 25kVAT feeding system of traction for main lines, yards, and connecting tracks to Indian Railways to provide traction power to trains as per traffic plan at table 4.7.1-3. The principal components of the scope of work shall include but not be limited to the following:

a) Complete 25kVAT Feeding AC, Flexible polygonal sagged simple Catenary Overhead Equipment (OHE) including parallel reinforcing conductors along the track, foundations, steel structures, Protective conductors, 25kV feeder and cross track feeders, Earth and associated insulators and hardware, jumpers, interrupters and isolators (other than those located in TSS, SSP and SP).

b) +25kV and -25kV cable/Overhead cross-track feeders and flexible cable feeder connections from track-side bus to the tracks.

c) Track Bonding and Earthing.

d) Survey and Safety Earthing of other adjacent steel structures alongside including those of Indian Railways alignment running alongside as per requirement.

e) Installation of 25kV/240V Auxiliary Transformers for LT Power Supply at level crossing gates, signal and telecommunication huts and station buildings including Automatic Change-over switch.

8.2 Factors Governing Design of OHE

8.2.1 Track Structure

Highlights of the Track Work Specifications' are furnished below: Following technical parameters in respect of track structure corresponding to 25 tonne axle load will be adopted. In future the track structure may be raised by 275 mm, provision for which shall be made while designing the OHE.

Table: 8.2.1-1
Track Structure

Points & Crossings		
a)	Main Line and Auxiliary Main Tracks and running Loops	60 kg Rail, 1 in 12 curved canted thick web switches with CMS Crossings on PSC Sleepers layout
b)	Minor Loops and non-running lines /Sidings	60 kg Rail, 1 in 8 1/2 curved canted thick web switches with CMS Crossings PSC Sleepers layout
Ballast Cushion below the bottom of the sleeper at the rail seat		
a)	Main Line.	350 mm.
b)	Loop Line & Sidings	250 mm
Sleepers		

a)	Sleeper	Mono-block concrete, rail seat for 60 Kg/m rails as per RDSO drawing No. T-7008 for 25 Tonnes axle load.

The relevant part of the Design Criteria to be followed by the other Contractors for the track construction is attached for information only for the Contractor to suitably design the Overhead Equipment structures for the tracks of the route.

8.2.2 Earth Work

The main features of the geometric parameters of the Earth work are furnished in the Table Below:

Table 8.2.2.1

Geometric Parameter of Earthwork

SN	Parameter	Value
1.	Formation Width (a) Embankment	 For Double Track : 13.5 m/14.5m
2.	Slope Gradient for Embankment	2:1 (H:V) (minimum)
3.	Slope Gradient for Cut	1H : 1V
4.	Thickness of Blanket	600mm
5.	Thickness of Prepared Sub-grade	1,000mm

8.2.3 Embankment

The embankment width provided is generally 13.5m/14.5m. For OHE design proposed to be used for Construction, drawings of actual curve, cant, gradient etc. shall be obtained from Track Contractor.

8.3 Maximum Moving Dimensions (MMD) and Structure Gauges

8.3.1 The MMD and Structure Gauges Drawing are shown below (Figure No. 8.3.1-1). The Contractor shall ensure that the proposed size and location of Works including Contractor's works are outside the Structure Gauge following the procedure as described in EDFC SSOD 2013.

8.3.2 Headroom clearances:

Head room clearances shall be as per SOD given in Fig. 8.3.1-1

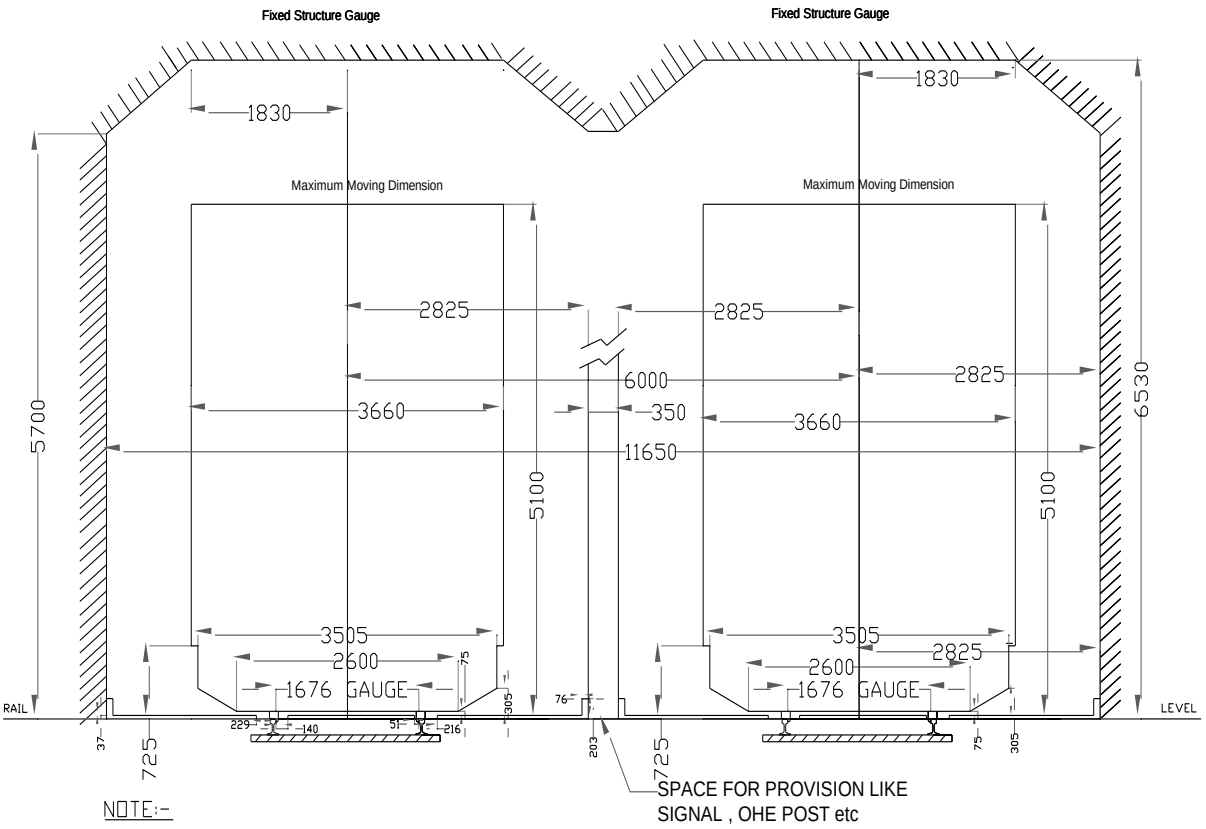
8.3.3 Provision in the designs for Low joints in the track:

For low or loosely packed joints a difference of 10 mm in the opposite rail shall be taken as the basis for estimating the displacement of the Pantograph with respect to its normal position.

8.3.4 Displacement of track due to slewing. The slewing allowance shall be taken as 100 mm.

DIAGRAM No. - 1
1676mm GAUGE

MMD AND FIXED STRUCTURE GAUGE FOR TUNNLE AND THROUGH GIRDER BRIDGES TO SUIT 2x25 Kv AC TRACTION CHAPTER - I



(i) ALL DIMENSIONS ARE IN MILIMETRES EXCEPT WHERE OTHERWISE SHOWN.
(ii) IF SPACE OF 580mm PROVIDED BETWEEN CENTRES OF TRACK FOR PLACEMENT OF SIGNAL POST THEN MINIMUM DISTANCE BETWEEN CENTRE TO CENTRE OF TRACK SHALL BE 6250mm. THEREFORE OVERALL WIDTH WILL BE 11650+250 = 11900mm
(iii) NECESSARY PROVISION SHOULD BE MADE IN OVERHEAD STRUCTURES AND OVERHEAD EQUIPMENT TO PRMIT POSSIBLE RAISING OF TRACK BY 275mm IN FUTURE TO CATER TO INCREASED HIEGHT OF TRACK STRUCTURE AND OTHER UNFORESEEN FACTORS SUCH AS RE-GRADING etc. .THEREFORE OVERALL HEIGHT ABOVE RAIL HEIGHTWILL BE 6805mm.

Figure 8.3.1-1: Maximum Moving Dimension and Structure Gauges

8.4 The Geometry of the Overhead Equipment for the Eastern Dedicated Freight Corridor

The structural design of Overhead Equipment adopted by the contractor shall follow the method of RDSO as applicable to the special parameters of DFC (EC) requiring increased height of contact system to permit passage of wagons (MMD 5.1 m) as well as the sizes and number of conductors required for the 25kV AT system of traction. It is to be noted that the designs shall continue to be safe for the ultimate raised height of the contact wire plus 275 mm for future.

8.4.1 Height of Rolling Stock:

Maximum height of the rolling stock, above Rail level 5.1m. This height of the Rolling Stock above rail level shall result in contact wire height above rail level as follows:

Normal at the support	:	5.60m
Normal mid span	:	5.50m
Minimum (anywhere in the span)	:	5.47m
Minimum under over line structure	:	5.42m

8.4.2 Setting distance (Implantation) of the structure face to center of adjoining track:

Normal	:	3.00m
Minimum	:	2.825m

On curves, additional "Curve Allowance" shall be provided as shown in the SOD. The setting distance for OHE mast near signal shall be set back as per ACTM requirement, so that signal sighting is not obstructed.
For portal upright, multiple OHE structure and anchor structure shall normally the 3.5m. Where such distances are not possible, maximum possible clearance, but not less than that required by the schedule of Dimensions for Eastern Dedicated Freight Corridor for fixed structure shall be adopted. However the contractor should propose the design for maintaining the setting distance Engineer for review.

8.4.3 Motive Power Pantograph Characteristic

The Pantograph details are as follows:

a)	Overall width (Including Horns)	2040mm
b)	Number of collector strips	2
c)	Collector material	Metalized carbon strips
d)	Working width of the head	1040 m
e)	Static contact force	7 ± 0.4 kg on OHE

8.4.4 The design and erection of OHE structures on bridges and earthing & Bonding of all structures shall be carried out in close Co-ordination with the Other (Civil and track work) Contractor.

8.4.5 The overhead equipment, which shall be of simple sagged polygonal type shall be designed for a maximum line speed of 120 km/h, and a normal operating speed of 100 km/h. Since there is a limitation of contact wire height, all OHE on the main lines and yards shall all have regulated equipment. Tramway equipment in yards shall not be permitted.

8.4.6 The Contractor shall undertake Catenary-Pantograph Dynamic Interaction (CPDI) simulation study for the MGS-SEBN & CPBH (excluding NKWD-DGO section) using a proven and fully validated computer based Multi Train Simulation Software. Technical criteria for the interaction between pantograph and overhead contact line are stipulated in EN 50367 and EN 50119.

8.4.7 **OHE structures on bridges/Viaduct/RFO.**

(1) Locations and details of Major bridges/Viaduct/RFOs may be referred to in the alignment drawings and typical arrangement drawings given in Part-4 of these documents. Structures to Support traction overhead equipment may be required to be provided on the bridge piers/ RFO piers. Exact span of Bridges/RFO shall be taken from the Civil contractor.

(2) On long bridges, RFO and long viaduct, OHE anchors and supports may also be required on bridge/RFO/structures itself. On through girder bridges, the overhead conductors and pantograph swept path shall have to be provided with

adequate electrical and mechanical clearances. These may need special designs to meet the additional clearances and support requirement.

(3) The design and erection of OHE structures on these bridges/RFO and earthing & bonding of all structures shall be carried out in close co-ordination with the Civil contractor as per DFCCIL Drg. no. HQ/EL/OHE/Pt.1/Earthing and HQ/EL/OHE/Pt.1/Mast.

(4) For OHE masts to be erected on bridges/RFO and viaducts, the CST Contractor shall provide holes for fixing Masts with base plates. The contractor shall interface with Civil Contractor so that masts with base plate are ordered and fabricated at the supplier's works and duly galvanized after welding and drilling holes in the base plate.

8.5 Design criteria for Overhead Equipment:

8.5.1 Minimum clearances to be adopted:

Table 8.5.1-1
Minimum E & M Clearance (mm)

Item	Normal
25kV Live metal to Earth	
- Static	250
- Dynamic (passing)	200
Phase Difference (50 kV)	
- Static	530
- Dynamic (passing)	350
Between conductors of different Electrical Sections	
Gap at Insulated Overlap	500
Gap at Un-insulated Overlap	200

Mechanical clearance from the pantograph to any fixed structure, excluding the registration assembly, steady arm or registration pipe of the cantilever, shall be not less than 200 mm. except at locations where a locomotive is expected to halt as a matter of normal operation. Clearance to steady arms and registration assemblies or tubes used for registration purpose, shall be not less than 35mm under worst case operating conditions including dynamic displacement of the vehicle, the pantograph as well as track and maintenance tolerances.

8.5.2 The following design features of OHE as on Indian Railways may be adopted:

a) Normal Encumbrance: (Axial Distance between Contact wire and the Catenary wire in a vertical plane) :1.4m.

b) Standard spans in multiples of 4.5 m from a minimum of 27 m to a maximum of 72 m.

c) Stagger of Contact Wire:

- On straight :200 mm
- On curved track : 300 mm

(d) The maximum distance between anti-creep to the Anchor structure is 750m.

(e) Structures: These may be of rolled Steel sections or fabricated.

8.5.3 The location of proposed RUB/ROB in place of LC gates should be considered while designing the OHE structure near LC gates. Proper Liasoning with civil contractor should be made in this regard.

8.6 Sectioning of Overhead Equipment

8.6.1 Introduction

Stations are generally 30km to 40km apart with crossing stations for giving precedence to trains and junction stations providing exchange with IR route. With reduced manning for operation it is proposed to make the switching of OHE for main lines and yard sections through remote control from the Operation Control Centre.

8.6.2 The OHE shall be sectionalized through remote controlled interrupter switching, so as to maximize the amount of operational track in the event of:

a) An overhead equipment failure

b) An isolation required for routine maintenance

c) Isolation required for emergency work.

The sectioning shall be minimum, to provide for flexibility of operation. The principles of sectioning are to be done as per RDSO guidelines. The sizes of the smallest sections that can be isolated automatically/from OCC shall have to be sectored.

8.6.3 Sub-sectioning and Paralleling Post (SSP)

8.6.3.1 The SSP sectionalisation shall be arranged such that movement to various lines and yard line is maintained, by isolating the smallest portion of tracks for maintenance or breakdowns. Portions of station yard can be made dead whilst the rest of the mainline and yard is energized and vice versa.

8.6.4 Sectioning and Paralleling Post (SP) and Traction Substation (TSS)

At SP and TSS locations there shall be sectionalisation to allow one sector to be isolated from the next section. The section isolations shall be arranged such that safe isolation can be made for maintenance purposes, whilst the adjacent section remains alive. The location of SP and TSS which need neutral sections, to be located such a way that there are no stop signals in vicinity of the neutral section.

8.6.5 Indicative Sectioning Diagrams

8.6.5.1 The indicative sectioning and wiring of lines may be referred from RDSO Drawings listed in Annexure-VII and Appendix A. The Contractor shall verify the drawing in regard to the indicated wiring & sectioning provided and shall submit his own proposal for the general supply and sectioning cum wiring diagram to the Engineer for approval. The Contractor shall not commence construction until the OHE layout Plan along with the sectioning diagram has received the statement of 'No Objection' from the Engineer.

8.6.6 At Junction stations there shall also be an isolation point at the boundary between the Eastern Dedicated Freight Corridor infrastructure and Indian Railways infrastructure through a neutral section. The IR sections are fed by conventional 25kV system while DFC is on 25kV AT feeding system and they shall be isolated by neutral section.

8.6.7 Position of Sectioning Switches (Interrupters)

The Sectioning switches (Interrupters)as required for facilitating the adequate sectioning shall be considered in the main line. Sectioning Switches(Interrupters)

shall be suitably configured to facilitate easy isolation from remote. Single Sidings/Yard side/loop lines shall be isolated through Motorized isolators.

8.7 Clearances

The minimum clearances between live conductors (including the pantograph) and any grounded fixed structure shall be in accordance with EDFC SSOD 2013.

Insulation over Catenary and feeder wire under all the bridges, FOB, ROB and Over line structures: The insulation level of the insulating sleeves considered if any shall confirm to EN 50124-1.

8.8 OHE Conductors

8.8.1 Sizes of Conductors

The sizes of conductors for the Main Lines are furnished in the Table No. 8.8-1 below.

TABLE: No 8.8 -1
OHE Conductors for Main Lines for each track

Conductor	Size (mm^2)	Material	Specification
Catenary	125	Cadmium Copper	Annexure - VI
Contact wire	150	HDGC	
Feeder Wire	288	AAAC	
Aerial Earth Wire	Of adequate size	ACSR	
Buried Earth Conductor	adequate size if required	Hot dipped galvanized stranded steel wire.	IS: 2629: 1985

8.8.2 Contact Wire

The contact wire shall be continuous, that is, splicing or jointing of the conductors is not permitted between terminations or between cut-in insulators. The contact wire shall confirm to RDSO specifications.

8.8.3 Catenary (Messenger) Wire

The catenary wire shall be continuous, that is, splicing or jointing of the conductors is not permitted between terminations or between cut-in insulators. The catenary wire shall confirm to RDSO specifications

8.8.4 Feeder Wire

Bare aluminium alloy feeder wires shall be installed per track, as per requirement. The contractor shall propose his designs providing the details of intervals and sizes of jumpers between catenary and the reinforcing conductors to ensure optimum current distribution and rating required.

8.8.5 Aerial Earth Wire and buried earth conductor

8.8.5.1 An aerial Earth wire shall be installed of reinforced aluminium strands with each track fixed termination shall be erected parallel to the OHE System and be simultaneously utilized as a common aerial Earth wire (AEW) and as a continuous path for normal current return and Fault Current return. The aerial Earth wire shall be grounded in such a way that two connection to Earth in each tension length are made near its ends.

8.8.5.2 The design of buried earth conductor, if required, shall be such that in case of short circuit, failure of locomotive and failure of insulators the step and touch potential shall not increase the values specified in EN 50122 corresponding to a breaker tripping time of 300 milli seconds. The buried earth conductor, if required, should be laid in such a way that it will have least impact on formation. If it is unavoidable to lay the buried earth conductor in the formation, it is desirable that buried earth conductor be laid at minimum design depth required to minimize the damage to the formation after conducting detailed studies of return current circuit/earthing arrangement keeping step and touch potential within permissible limits as per relevant code/standards under fault conditions. The methodology for laying the buried earth conductor shall be submitted to the employer/Engineer for approval before starting the work.

8.8.6 Splices, Clamps and other Tension Fittings for the Conductors

8.8.6.1 The fittings shall be tested in tension, in a special Jig to simulate the load characteristics experienced in service.

8.8.6.2 The tensile failing load of the fitting shall exceed the failing load of the wire or stranded wire with which it shall be assembled and used.

8.8.6.3 When the fitting is tested and assembled to the allocated wire or stranded wire the assembly shall achieve 85% or greater than the specified tensile failing load of the wire or stranded wire.

8.8.6.4 Splices are primarily for use during maintenance and shall not be used in the contact and/or catenary wires by way of installation or repair.

8.8.6.5 Unless otherwise specified in this bid document, all bolts, studs, nuts, washers and pins used for the current carrying conductors shall be of stainless steel or high tensile copper alloy. However, for all other applications on structural steel, galvanized steel may be used as a measure of prevention of corrosion.

8.9 Electrical Connections

8.9.1 The connections shall be robust, to withstand both static and dynamic loads, wind, along track movement. (Temperature variation conductors) and operational vibrations.

8.9.2 There shall not be any hot spot in the electrical connectors.

8.9.3 Where dissimilar connecting materials are used appropriate measures shall be employed to mitigate the risk of bimetallic corrosion.

8.9.4 Protective bimetallic tapes and shells shall be installed at clamps and terminals used with aluminum and copper conductors and cables.

8.9.5 Nominal working pressure shall be kept up to compensate the permanent temperature deformations and generation of local overheats.

8.9.6 The tapes and shells shall envelope 10mm outside of clamps on both sides.

8.9.7 The Conductors shall not suffer any permanent damage or deterioration under normal train operation.

8.9.8 Longitudinal buried Earth Conductors along the track may be proposed as per earthing, if required. The Aerial Earth Wire, if required shall be run on the OHE Structures with Earth connections at intervals to ensure the accessible Touch Potentials to rail the structure remain within safe limits. These will be connected to buried conductor at regular intervals.

8.9.9 The Contractor shall where practical, optimize on the number of parallel feeders and shall install them where necessary.

8.9.10 The Contractor shall install a minimum of two feeder wires for the Autotransformer feeders.

8.9.11 The Contractor shall identify any operational limits in the design report.

8.9.12 **Jumpers and Feeders**

8.9.12.1 Flexible Jumper Wire shall be fabricated from soft or annealed, high conductivity copper with stranded conductors. The relevant RDSO specification for Annealed stranded copper conductor for jumper wire is ETI/OHE/3(Latest).

8.9.12.2 Flexible jumpers of adequate cross-section, suitable material and standard construction shall be provided at un-insulated overlaps (air gaps), points and crossings to carry and maintain the anticipated load and short circuit currents.

8.9.12.3 In-span potential equalizing jumpers may be fitted between catenary and contact wires, to ensure that burning of dropper components does not occur.

8.9.12.4 All conductors shall be above contact wire level in design and jumpers shall be connected to contact wire in such a way that if it comes out of contact wire PG Clamp, it does not infringe with pantograph movement.

8.9.12.5 Wherever the clearances as stipulated are not obtained, special insulation arrangements shall be proposed to the Engineer for his acceptance.

8.9.12.6 Anti-theft jumper of size 50 mm2 copper nominal, 19/1.8 mm in size shall be used in out of run wire of OHE and copper cadmium anti-creep wire as an anti-theft measure.

8.9.13 **Droppers**

8.9.13.1 Each dropper shall be of solid copper wire as per IS 282-1982 of minimum dia 5mm and two dropper clamps, one of which is connected to the contact wire, and the other to the catenary wire. The maximum resistance at the joint between the dropper wire and the clamp, and at the contact point between the clamp and the catenary and contact wire, shall be less than the resistance of the conductor of the same length. The maximum temperature rise at the joint and at the contact surface shall not be higher than that of the conductor. The tensile breaking load of the complete joint shall not be less than 90% of the failure tension of the dropper wire.

8.10 Cantilever Assemblies

8.10.1 The contractor shall adopt fittings as per RDSO Specification for conventional cantilever system on DFCC. This system shall be compatible with the footprint of the existing Indian Railway OHE Mast / Portal designs so that existing cantilever assemblies are interchangeable with the IR Assemblies.

8.10.2 The number of components and their sizes shall be as few as possible.

8.10.3 The Contractor shall ensure that the range of cantilever frame components is suitable for the loadings and applications. A report with calculation and FEM analysis is to be submitted to Engineer in this regard.

8.10.4 The cantilevers shall be designed such that they can be pre-assembled off site for delivery to site.

8.10.5 The contact wire registration profile shall accommodate the permissible extremes of uplifted and swayed pantograph movement in addition to the effects of track tolerances and include allowance for mechanical and electrical clearances

8.10.6 Fittings connected to the in-running contact wire shall utilize the wire groove and shall be shaped to maximize clearances to the pantograph head when uplifted by the extreme operating running conditions and shall take account of pantograph and contact wire wear.

8.10.7 Assemblies shall allow for the adjustment of contact wire stagger and the equivalent catenary adjustment by 75mm either side of the designed position without changing components.

8.11 Equipment, Fittings, Components

8.11.1 All fittings, components and materials to be used on the Project shall be of material and metallurgy suited to the purpose and shall subject to prototype tests. If prototype sample of an identical item has, in the past, been approved in connection with a previous electrification Project on Indian Railways or Metro Railway and has been in service for at least THREE years prior to date of tender opening of this project work, such item shall be exempt from prototype test. Any approval to the prototype tests by the Engineer in no way would absolve the Contractor of his responsibility under the terms of the contract for the equipment.

8.11.2 In order to protect the insulated cables and associated equipment from atmospheric voltage surges on the OHE located outdoors, RSS/TSS and Traction Switching Station feeder cable; connections to the OHE shall be provided with gap less lightning (surge) arrestors.

8.12 Auto Tensioning Devices

ATD should be designed as per RDSO Specification No. TI/SPC/OHE/3PHTATD/0150(09/2016) with latest amendments. The Contractor shall ensure that the ATD with associated components is suitable for the loadings and applications. A report with calculation is to be submitted to Engineer in this regard.

8.13 Stainless Steel Wire and Wire Rope

Stainless steel wires shall be in conformity with RDSO specification No. TI/SPC/OHE/WR/1060(08/2006) with latest amendments. The Contractor shall validate the suitability and submit a report to engineer.

8.14 OHE Assemblies, Fittings and Hardware

8.14.1 Fasteners and Fixing for structures

All threaded fasteners, washers, headed pins and locking pins etc., shall generally conform to appropriate Indian standards applicable to materials, form, threads and protective coatings. These requirements shall include, but not be limited to, the following:

a) Hot dipped galvanized bolts shall have a minimum diameter of 16 mm. Bolts below this diameter shall be of stainless steel.

b) Hot-dipped galvanized fasteners with male threads shall normally be spun, immediately after removal from the galvanizing bath to remove excess zinc from the threads.

c) Brushing of the threads is not permitted.

d) Hot-dipped galvanized nuts shall have threads cut before galvanizing.

e) The bare metal shall be protected from corrosion with an inhibiting oil or suitable grease.

f) All other bolted joints shall have a minimum of 2 threads showing.

g) All bolted joints for greater than 12mm in diameter shall be by a single flat washer and double nuts application.

h) Structures or brackets required to be fixed to masonry or rock shall be attached by approved anchor bolts inserted into pre-drilled holes, filled with an approved chemical fixing product, which sets rapidly to firmly fix the anchor bolts in position.

i) In each case the location of the fixing shall be subject to the approval of the Engineer, and shall subsequently demonstrate the efficacy of the fixing to the satisfaction of the Engineer, who may require sample pull-test or torque tests to be performed.

j) In the case of chemical fixings, the Contractor shall be expected to adhere to the manufacturer's instructions for installation, and shall bring these to the attention of the Engineer before installation commences.

k) The Contractor shall prepare and submit for the Engineer's approval a list of all applicable specifications for threaded fasteners, washers, headed pins and locking pins.

l) Locking pins, washers and fasteners shall be of stainless steel.

8.15 Structure/uprights and their foundations

8.15.1 Overhead equipment structures for the main line tracks shall be mechanically and electrically independent and shall not be located between Up and Down tracks except where specifically approved by the Engineer. In station yards, portals spanning over 4 tracks shall be erected. For this purpose, adequate track centers shall be provided by the other (Civil and Track Work Contractor). Designs for steel structures shall comply with IS 800-2007 Indian Standard Code of Practice for use of structural steel in General Building Construction.

8.15.2 For Methods of Designs of Structures and Foundations, Indian Railways Design Manual for Electric traction shall be followed. The Concrete for the foundations shall be of Mix M10 with proportion as given in IS 456. For grouting, muffing, and embedment of structures in concrete the nominal mix of the concrete shall be M15. Aggregates shall comply with the requirement of IS 383. Graded aggregate of nominal size 40 mm size may be permitted. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salt, sugar, organic materials or other substances that may be deleterious to concrete. Proportions for Nominal Mix Concrete should be as per table 9 of IS 456. Batching shall be adopted as per clause 10.2 of IS 456. Concrete shall be mixed in a mechanical mixer as per clause 10.3 of IS 456. Concrete shall be compacted using mechanical vibrators as per clause 13.3.1 of IS 456. Strength of CONCRETE MIX shall be in accordance of clause 15 of IS 456. The foundations design shall be based on structural loading calculations at each structure location.

8.15.3 Frequency of sampling for Cube test

The minimum frequency of sampling of concrete shall be in accordance with the following:

Quantity of Concrete in the Work, m^3	Number of Samples
1-50	1 Plus one additional sample for each additional $50m^3$ or part thereof

At least one sample shall be taken per mechanical mixer for each day.

8.15.4 The Contractor shall carry out his own geotechnical survey which shall be the basis for design for foundation. The Contractor shall undertake sufficient Geo Technical investigation to demonstrate that the foundation designs are adequate.

8.15.5 Location and Setting distance of Structures:-

a) Location of structures shall be selected after ensuring that there are no infringements and they do not obstruct roadways, pathways, run of cables, drains, or the sighting of DFC or IR signals etc.

b) Setting distance of structures (distance from center line of track to face of mast) shall normally be 3.0 m plus curve allowance as required. Setting distance of portal upright, multiple OHE structure and anchor structures shall normally be 3.5 m. Where such distances are not possible, maximum possible clearance, but not less than that required by the Schedule of Dimensions for Eastern Dedicated Corridor for fixed structure shall be adopted. However the contractor should propose the foundation design for maintaining the setting distance to Engineer with full design calculation for review for such locations.

c) To ensure provision of safe current collection under adverse conditions, the deflection of masts on top of the OHE structure shall not exceed 8 cm and the mast shall be erected such that it becomes vertical on application of permanent loads. The mast shall not further deflect more than 8 cm under the wind load. Torsion deflection under permanent loads shall not exceed 0.1 radian.

d) The value of setting distance of masts/structures shall be painted on each mast/structures. The figures shall be 25mm in size in white on a red background. In addition, the track level shall also be marked on the mast/structure by a horizontal red painted stroke.

e) In case of structures carrying counter-weight assemblies, the term “setting” shall refer to the minimum distance of the mast including the counter-weight from the track center. The minimum and maximum travel of counter weight shall be marked on the mast.

f) Structures shall be numbered in accordance with the standard numbering given in the finalized overhead equipment layout plans. Enameled number plates at eye level from a locomotive driving cab (approx. 3m above rail level) shall be provided on mast or structure. Retro-reflective number plate at each neutral section boards and two in each track kilometer shall be provided as per RDSO guidelines.

8.15.6 Construction design shall include the Construction Employment Schedules for structures and the foundations for different situations of loading expected to be encountered on the route.

8.15.7 Tolerance in Erection:

1	Span Lengths shall not vary more than	+/- 50 mm
2	Cumulative error in all spans in one km shall not exceed	+/- 1000 mm
3	Height of Contact Wire	+/- 20 mm
4	Dropper Length	+/- 5 mm
5	Dropper Location	+/- 100 mm

8.16 Outdoor Steel parts

8.16.1 All the steel structures and small part steel for carrying overhead equipment shall be galvanized after drilling and fabrication to RDSO Specification ETI/OHE/13 (Latest). Painted structures shall not be used. In case of need to use non-standard SPS at special locations, these shall be with clamps to avoid drilling of galvanized mast sections.

8.16.2 Anti- Climbing Guards

a) Anti-climbing guards shall be provided for all structures supporting Auxiliary Transformers.

b) Screens and anti-climbing guards shall be provided on OHE supports at locations where any person can either touch or gain access to live overhead conductors.

c) Where deemed necessary the equipment and critical points shall be clearly identified with warning and danger signs positioned at appropriate intervals, distance and heights.

d) All safety critical items shall be secured by bolts, clamps, etc., and shall be fitted with shake proof, self-locking washers or secured with split pins.

e) The device shall be clamped to the structure that it protects, and no drilling of the structure shall be acceptable.

f) The guards shall be positioned to allow unimpeded access to maintenance staff during the normal course of their duties.

g) For providing guards & screens on civil structure the issue should be settled with the civil contractor as an interface item.

8.17 Insulators

8.17.1 All Insulators shall be suitable for use in tropical environment. In polluted and vandalism prone areas silicone insulators conforming to RDSO Specification No. TI/SPC/OHE/INSCOM/1070(01/07) shall be provided and all other places only porcelain insulator conforming to RDSO Specification No. TI/SPC/OHE/INS/0070(04/07) shall be provided.

8.17.2 For this purpose, the Contractor shall undertake a survey to categorize levels of pollution along the route in order to provide insulators suitable for polluted zones, structure protection and other protective measures for the OHE and get it approved from Engineer. The method to determine the level of pollution for insulation and corrosion resistance is given in RDSO instruction No. TI/MI/0040(04/05). Also the contractor shall study and adopt the guidelines as per the standards of adjacent section of IR.

8.17.3 All insulators should be tested before erection and proper record should be maintained. Yellow band should be painted on cap of the insulators indicating date and year of testing and manufacturer's name.

8.18 Design of Neutral Sections and Section Insulators

The route shall be provided with Automatic colour light signalling. Also the route is undulating with 0.5% grade. The location of neutral section for the TSS, SP and at interface with IR in Junction Stations is to be judiciously selected such that trains are able to coast through the neutral section with power off without least risk of stalling. As such, their location shall be judiciously selected and shall be subject matter for interface coordination with the signaling Works.

8.19 Contractor's Design Responsibility for Overhead Equipment System

8.19.1 The Contractor shall be responsible for the detailed design, fabrication, furnishing and installation of a complete OHE and/or selection of machinery and components to be used for the works on the main route and the station yards, including but not necessarily limited to, the following elements:

a) OHE Structural Steel masts and portal structures for support of the Overhead Conductor.

b) Small part steelwork Fabrications – galvanized small part steelwork (SPS) assemblies required to support OHE, some of which may be special structural assemblies.

c) Earthing and Bonding Systems and components.

d) Lightning (Surge) Arresters – for the protection of the OHE from lightning and accidental power surges from any cause as also particularly exposed locations on high banks and approaches to long span important bridges.

e) Stainless Steel, Copper Wires and Wire Ropes – for droppers, cantilever assemblies, anti-creep wires, cross-span and wire pull-off assemblies if used.

f) OHE Assemblies, Fittings and Hardware

g) Bare Conductors and connections.

h) Insulated Feeder Cable

i) All clamps, current jumpers and terminations – Splices.

j) Insulators – Insulators of all types including bridging and non-bridging section insulators for OHE sectionalizing applications.

k) Sectioning switches (Interrupter) for main line sectioning.

m) Disconnecting Switches – Pole mounted outdoor, local or remote operation with indications for motorized operation for loop line/yard line as required.

n) Overhead Equipment Installation - including structure numbering.

o) 25kV conductors cross-feeder overhead bare or through single core 66kV cables from switching stations to the Overhead equipment.

p) + 25kV feeder from TSS and Switching Stations to the super-masts on the OHE structures and their connections

q) Protective Earth wire and its installation/buried conductor and its installation as per requirement.

r) Earthing and Bonding of masts with tracks and ground.

s) Running Rail Bonding and Return Current Connections & transverse equalizer bonds wherever required.

t) Special Tools and Equipment.

u) Tests on completed sections of the installation at the Traction Substations and Switching Stations and on the Overhead Equipment – including inspection, testing, measurement and acceptance procedures for sections of OHE together with their implementation.

v) Assist in obtaining Statutory Clearance for charging the OHE to the Employer.

w) Anti-theft charging of Completed sections of the Overhead Equipment prior to commissioning

x) System Testing and Commissioning,

8.19.2 The fittings, structures and conductors as far as reasonably practicable standardized throughout the whole length of this section of Eastern Dedicated Freight Corridor.

8.19.3 The Contractor shall work out in details the following as a minimum: -

a) Based on the layout of the alignments and track layouts produced by Civil Contractor, the Contractor shall finalize a suitable sectioning arrangement indicating location of insulated overlaps and section insulators, showing therein also the feed arrangement to each insulated section of OHE and furnish the drawings for approval of the Engineer.

b) The contractor shall prepare a design options report for other options for design and installation of the OHE foundations and masts.

c) The report shall minimize the number of mast types and foundations as far as reasonably practical.

d) The report shall clearly indicate the proposed construction method, construction time per foundation and mast and the methodology used.

e) The report shall be submitted to the Engineer for Review and Acceptance as a part of key design mile stone in the design phase.

f) The OHE lay out Plans submitted by the Contractor shall indicate design of each OHE support, covering all overlaps, anti-creeps, anchors and the crossover OHE lines giving major details of structure setting distances, spans, staggers clearances available etc. at critical locations, the type of structure required such as type of masts or portal and their foundations.

g) All insulated and un-insulated overlaps, termination points, tension length of each conductor, location of continuity and equalizer jumpers.

h) At locations with restricted Overhead Clearance OHE profile drawings showing Contact wire gradients and clearances obtained shall be submitted including that under over line structure and through girder bridges.

8.20 Basic Designs and drawing Submittals:

8.20.1 The Contractor shall prepare and submit the Basic Traction OHE arrangement, Structure and portals report and prepare the basic standard drawings and designs for this section and with conductor sizes as indicated in this document. On approval of the basic designs and the drawings, Standard Employment Schedules for use in the Construction Drawings for Overhead Equipment shall be submitted for Acceptance by the Engineer within 45 days.

8.20.2 The Contractor shall, thereafter, prepare and submit a detailed final design, together with a hardware applications design appropriate for sections of the whole Project depending on the Wind loads applicable to the terrain on that section. The submittal shall include a tabulated allocation chart of all parts for the OHE.

8.20.3 The contractor shall survey the route and make out a list of locations which shall come on high banks and approach to bridges & RFO and suggest reduction of spans to minimize blow off of contact wire. Contractor shall keep the margin while designing span at such locations.

8.20.4 The design of the support and registration assemblies shall assure adequate clearance from the pantographs under dynamic conditions.

8.21 Drawings for Review:

8.21.1 The Contractor shall be required to submit the following drawings /plans for approval of Engineer

These shall include but not be limited to:

a) General Traction Power Supply diagram.

b) Schematic Sectioning diagrams.

c) Pegging Plans.

The pegging plan for sections to be equipped indicating the type of overhead equipment, locations and size of masts, span lengths used and other general particulars. On-site verification of the pegging plans shall be carried out and based on final pegging plan, OHE layout diagram shall be prepared.

d) OHE layout diagram

The OHE layout plan incorporating following information shall be submitted:

- The run of wires in different thickness or colour in special cases and terminations.
- Exact position of all cut -in-insulators, including section insulators.
- Direction and value of stagger at each traction structure location.
- Clearance of live conductors to structures in the vicinity including bridges, signals, gantries etc.
- Alignment and layout of feeders.
- Jumper connections and connection to switches and Switching Stations.
- List of infringements.
- Kilometer numbers and type of structures.
- Location and numbers of isolating switches (interrupter) and isolators.
- Detailed sectioning diagram drawn to a convenient scale showing section insulator number, switches, elementary sections and connections to Switching Stations.
- Tables giving references of profile drawings, feeder layout plans and other relevant drawings.

e) OHE profile drawings: The Contractor shall prepare an overhead equipment profile drawing showing the actual height of the contact wire at each structure, where gradient in contact wire height is provided and under each over line structure, on either side of the structure until normal height of contact wire is restored.

f) Cross-section drawings for each structure showing guy rods, if any, indicating the cross section of formation, nature of soil, type of foundation block, structure proposed, reverse deflection of the structure and all necessary particulars for erection of the foundation and the structures.

g) Structure erection drawings indicating track layout, cantilever arrangement, height of contact wire, catenary wire, encumbrances, stagger, setting distance of masts etc.

h) OHE foundation drawings

i) The foundation design shall be based on structural loading calculations at each structure location.

j) Track Bonding plan

k) Return circuit Bonding plan of running rails in interface with Track construction Contractors.

l) Safety, Earthing and Bonding Code and Plan. Contractor shall methodically draw out safety Earthing and Bonding Code This shall include work also to be taken up by Other Contractors and also by the adjacent Indian Railway Routes to ensure

the induced electromagnetic induced High Voltages in the metalwork is minimized to below the thresh hold safe Touch Potential on this section.

8.22 Construction Design Drawings:

Construction Drawings for each stage of the work shall be submitted wherever required to the Engineer and the field work shall only be taken up for that stage only on issue of 'No Objection Certificate' for only that stage of the work.

8.23 As Erected Design and Drawings:

The Construction drawings shall be corrected on completion of each stage of work to correspond to that as finally constructed at site. These drawings and the designs to which the structures and the Equipment have been erected shall be termed "As Erected" Drawings and designs and shall be submitted for records to the Employer.

8.24 Earthing and Bonding Systems for OHE

The work includes the earthing and Bonding of steelwork.

a) Connectors and Clamps: Bolts, washers and lock nuts shall be of high-copper alloy or aluminium bronze. Ferrous hardware will not be acceptable. The connections which are not to be opened for maintenance purpose should be brazed.

b) Specification Connectors: Exposed and buried Earth connections shall be of type and in conformity with EN-50522. Details to be submitted for review by Engineer. The connections which are not required to be opened, should be exothermic welded.

c) The contractor shall prepare detailed EMC plan as per EN 50122-1.

d) Laying of buried earth conductor if required.

e) Earthing & Bonding for Metallic Over Line Structure, Bridges, Platform, Fencing and Track Side Structures shall be carried out by the contractor.

- END OF CHAPTER -

9 Installation, Testing, Commissioning

9.1 General

9.1.1 The Contractor shall develop a full test plan including Integrated, commissioning & performance verification and submit for review by the Engineer at least 2 months before any on site tests are to be performed based on the relevant standards/specifications.

9.1.2 Test Certificates

Three sets of all principal test records and test certificates are to be submitted by the Contractor for review by the Engineer in accordance with the specifications relating to the item, component or equipment of this contract. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

9.1.3 Factory Acceptance Tests

9.1.3.1 FAT shall comprise Type Tests/Sample Tests/Routine Tests/Life Endurance and Destruction Tests/any additional tests requested by the Employer's Personnel.

9.1.3.2 The testing shall be conducted such as to simulate the working conditions as closely as possible.

9.1.3.3 The contractor shall facilitate the Employers representative/ Engineer/ RITES/ RDSO to inspect the works and monitor all tests and have excess to all testing records.

9.1.3.4 Upon the request of the Engineer, destructive tests shall be got carried on components and assemblies to verify the design loading as required according to the relevant specification and factory acceptance test.

9.1.3.5 Type testing of equipment shall be witnessed by employer/engineer or both based on test program approved by Engineer.

9.1.3.6 The material inspection is to be conducted by the contractor and witnessed by the Engineer and/or the Employer representative. The Employer may depute its representative or nominate any other independent inspection agency, at his own cost, such as RITES, (in addition or as replacement) for supervising, monitoring and inspection of raw/final 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 four 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.

9.1.3.7 All costs associated with the Testing shall be borne by the Contractor. However this shall not include allowances for hotel and expenses for the person witnessing/certifying the test on behalf of the engineer/Employer representative. The cost of the Employer's personnel /Employers representative attendance for FAT/Type test will be borne by Employer including the cost of inspection charges of third party (if any) engaged by employer for witnessing.

9.1.3.8 The contractor shall bear all expenses including hotel/travel/cost of witnessing if any incurred due to retesting caused by defects or failure of equipment to meet the requirements of the contract in the first instance.

9.1.3.9 All the FAT which comprises of Routine test/special test/any other test shall be conducted by RITES/PMC/DFCCIL representative only after taking due approval of Competent authority of DFCCIL.

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10 Contractors Responsibilities for on-site Testing

10.1 General

10.1.1 The Contractor shall be responsible to carry out all tests as required by the Engineer, in conformity with relevant specifications/approved documents. During the course of erection, the Employer's Personnel shall have full access for inspecting the progress of work.

On completion of erection and prior to commissioning, all equipment shall be tested and test plan to demonstrate that it is entirely suitable for commercial operation.

10.1.2 The Contractor shall be responsible for providing temporary general electricity supply, all instruments, gauges, test equipment, tools, accessories, Personnel, services and any other facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, etc. to expedite testing process. All test equipment shall be accompanied with the appropriate calibration certificates from an approved testing authority.

10.1.3 The OHE commissioning shall include as a minimum:

(a) Visual inspection: This shall include check for accuracy of construction for ensuring that all the structures, equipment, insulators, jumpers and conductors have been erected as provided in approved Drawings and they are not damaged and remain in healthy state.

(b) Dimensional Checks: This shall include dimensional checks to ensure the execution of permanent Works are within the limits of tolerance permitted so as to permit the current collection by locomotives to be satisfactory. The Structure Erection Dimension shall be checked by using the Tower Wagon. The contractor may use the tower wagon of DFCCIL free of cost.

(c) Final Physical Check: This shall validate as a minimum that all Earths are removed, wires are present and in good condition, nothing infringes with OHE and all insulators are undamaged and present & auto-tensioning devices are installed and are functional. All jumpers are correctly installed.

(d) Clearance for Test Charging: This test shall be undertaken in each Elementary Section, to ensure that each Elementary Section can be successfully isolated from neighboring Elementary Sections.

(e) Test Charging

(f) Anti-theft Charging

(g) Tests Prior to Commissioning of a section

(h) Short circuit testing: Each Electrical Section shall be subject to minimum of two electrical short circuits, one at the remote end under Normal Feeding and one short circuit at using the extended feeding arrangements. This test shall confirm the mechanical integrity of the OHE and validate that the substation protection systems function correctly.

(i) Current collection test.

(j) The contractor will submit detailed method statement for various installation and testing to the engineer for approval.

10.1.4 The Contractor shall be responsible for surveillance and security of the power supply systems maintaining control of the substation, padlocking of Switchgear and

circuit breaker units, distribution switchboards, power panels, etc. throughout all energisation stages of the installation.

The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Employer takes over the System.

10.1.5 The Contractor shall interface with the other Contractors to assure no downstream cables or other electrical equipment is energized before it has been tested and before other involved Contractors facilities are ready and secured.

10.1.6 The Contractor shall submit details and method statement of all tests prior to testing and all tests scheduled to be carried out in the presence of the Engineer and to his complete satisfaction.

10.2 Re-Testing

10.2.1 When defects are detected in the equipment accessories, etc. during the commissioning tests, the Contractor shall ensure that adequate spares are kept on site to attend to these defects.

10.2.2 Should the plant or any portion thereof fail to give the performance required, then any further tests that may be considered necessary by the Engineer shall be carried out in a similar manner by the Contractor.

10.2.3 If any item fails to comply with the requirements of this Specification in any respect what so ever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item. The item may be resubmitted after necessary modification adjustment or replacement for further inspection or test.

10.2.4 In the event of the defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor at his own expense, after carrying out the tests as per the relevant specifications for the acceptance by the Engineer.

10.3 Power Supply Installation Tests

10.3.1 Installation Test

a) An inspection and visual verification of ratings and connections of equipment, instrument transformers and auxiliary circuits, installation tests shall be carried out.

b) After installation of equipment, visual inspection and operational tests on un-energized equipment shall be carried out to check the following:

a) Cleanliness;
b) Workmanship;
c) Confirmation of items conforming to ratings specified;
d) Water and dust proofing;
e) Leveling, mounting and positioning;
f) Joints and connections tightness;
g) Cables – dressing, bending radii, jointing and finish at terminals;
h) Clearances and dimensions in conformity with drawings;
i) Earthing and Bonding;
j) Functioning of circuit breakers, interrupters, isolating switches and their interlocks;
k) Protection devices;
l) Phase sequence verification;
m) Conformance to as built records.

n) Earth resistance measurements – individually and of the subsystem and system as required.

10.3.2 Insulation Resistance

The insulation resistance of all 220kV/132kV and 25kV circuits shall be tested with an insulation tester. All LV circuits comprising AC and DC auxiliary circuits shall be tested with a 500 V insulation tester.

10.3.3 Continuity Test and Contact Resistance

Continuity of all circuits shall be verified. Contact resistance of all high current joints and bolted contacts, especially the joints of 25kV conductors and the running rails for return current shall be measured with a Ductor set with a resolution of 1μΩ. Earth system joints shall also be measured.

10.3.4 Protection Equipment

a) Tests on Current Transformers

i) Insulation resistance
ii) Winding resistance
iii) Polarity or Connections up to equipment terminals.
iv) Ratio and magnetization curve verification

b) Tests on Voltage Transformers

i) Voltage ratio
ii) Insulation resistance
iii) Polarity of connections up to the equipment terminals.

c) Secondary and primary injection tests:

Tests shall be carried out at a minimum of three settings if multiple settings are available. Test results of operation boundaries and operating times shall be recorded.

d) Batteries and Chargers

Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger. Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures.
No addition of electrolyte is permitted during discharge tests. The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.

e) Control, Indication and Alarm Functions

Insulation resistance and continuity of all cores of cables shall be identified and tested. The correct functioning of all control, indication and alarm devices shall be verified.

f) Switchgear

All switchgear, including circuit breakers, interrupters, isolating and earthing switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory. SF6 gas leakage test shall be performed where applicable. Closing time for all circuit breakers shall be verified.

g) Instruments and Transducers

All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

h) Power Transformers (220kV/132kV & 132kV/54kV)

Voltage ratio at all taps, functioning of tap changers and insulation measurements shall be performed. Simulation shall be carried out to determine correct operation of Bucholz gas alarm and gas surge relays. Test shall be undertaken in accordance with those set out in relevant standard ETI/PSI/124 or latest standards.

10.4 Partial Acceptance Test

10.4.1 These tests form part of on-site and System Acceptance Tests as part testing of the equipment and system.

a) Functional Tests and Interlock Tests

b) All control and protection functions and electrical/mechanical interlocks shall be tested.

c) Primary Injection Tests

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

d) AC/DC Pressure Tests

The insulation resistance of all circuits shall be measured before and after the DC pressure test. The minimum phase-to-phase and phase-to-earth insulation resistance shall be 100 mega ohms.
Pressure tests shall be carried out on completed cable lengths of High Voltage cables in accordance with IEC 60502.

10.4.2 The Contractor shall submit details and method statement of all tests prior to testing and all tests scheduled to be carried out in the presence of the Engineer and to his complete satisfaction; in event of the Engineer not being present on schedule, tests may proceed with condition that records shall be put up to the Engineer.

10.5 System Acceptance Tests

10.5.1 Energisation

a) The Contractor shall submit operation safety rules and procedures to Employer's Personnel before Energisation.

b) All power equipment shall be subject to inspection by inspectors from the Electrical Inspectorate of Employer before Energisation. The Contractor shall ensure all Employer's requirements are met.

c) The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Employer's Personnel, the Contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment or of overhead equipment or connections of traction lines.

10.5.2 Tests

SAT shall include but not be limited to:-

a) Functional tests of SCADA system.

b) Integrated Tests with Employers Train Operator.

c) **Short Circuit Tests on OHE:** Short Circuit Tests on 25kV overhead lines shall be carried out to prove correct operation of protection equipment and to ensure that

the dynamic strength requirements of overhead equipment are met. Short Circuit Tests shall be carried out on every overhead equipment line feeder.

d) **Current Collection test**: The Contractor shall conduct current collection tests as per EN 50317 to demonstrate that a newly installed overhead contact line satisfies the quality requirement for 100 kmph speed. The behavior of the OHE will be watched at the various speeds. Current collection shall be considered unsatisfactorily, if any blue flash is observed, indication that the contact between the Contact wire and Pantograph is no smooth.

10.6 Integrated Testing and Commissioning

10.6.1 Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the DFC systems operate satisfactorily between one another and meet all specified requirements for design, operability, safety, and integration with other works and systems.

These tests shall be entirely within the requirements of one or more of the Project Contracts or they shall involve a multiplicity of Contract procedure. The final Integrated Testing and Commissioning shall be carried out after the SCADA system and OCC have become operational.

10.6.2 Those systems that can be tested without depending on the running of trains, such as SCADA system, etc. will have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these “trainless” system tests be identified and resolved prior to the commencement of test running.

10.6.3 The following is listing of those Integrated Testing and Commissioning functions that necessarily be integrated with others to demonstrate that the equipment and controls installed therein meet the Contract Specifications and demonstrate a safe-to-operate condition.

a) RSS,TSS, SSP and SP failure mode test.
b) Remote control and monitoring test through SCADA system at OCC.
c) EMI/EMC tests.
d) Touch/step potential tests.

10.6.4 On-load Tests and Directional Tests:
Voltages and currents injected into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

10.7 Performance Verification

10.7.1 The Contractor shall carry out all Performance Tests to verify that the performance of the System meets the Employer’s Requirements

10.7.2 The measurement of EMI levels at locations to be specified by the Engineer. Such measurements shall be carried out prior to energisation of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels comply with the requirements of this Specification.

10.7.3 Should the performance of the System deviate from the Particular Specification, the Contractor shall make every effort to rectify the deviation in the shortest possible time, and to the satisfaction of the Engineer.

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11 Works Installation

11.1 General Requirements

11.1.1 The Contractor shall comply with all Enactments in executing the Works, including but not limited to all statutory provisions on occupational health and safety.

11.1.2 The Contractor shall co-ordinate with Other Contractors in the execution of the Works.

11.1.3 The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.

11.1.4 The installation of all equipments shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

11.1.5 Only appropriate tools, plants, equipments and vehicles shall be used. The Employer reserves the right to prohibit the use of particular tools and vehicles.

11.1.6 Installation of all equipment shall conform to the best industry practices.

11.1.7 Precautions shall be undertaken to ensure the safety of Personnel and equipments for all installation works.

11.1.8 The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices. These hazards shall be clearly identified in a hazard log that included in the method statement. These hazards shall be briefed to all site staff at the beginning of each shift. All site staff will sign the briefing sheet.

11.1.9 The Contractor shall ensure that all areas of work are sufficiently illuminated for the works to be undertaken and that a safe system of work is employed for all activities.

11.1.10 The Contractor shall operate a robust system for the control of persons entering or working upon the site. The system shall include as a minimum:

a) Name of all employees;

b) personal identification, with photograph;

c) levels of competency;

d) date of expiry;

e) date of issue;

f) signature; and

g) Name of all visitors.

The site identity pass shall incorporate measure to ensure that the pass cannot be easily counterfeited, forged or copied.

11.1.11 The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

11.1.12 The Contractor shall submit details and method statement to Engineer of all procedures prior to installations to his complete satisfaction.

11.2 Specific Requirements

11.2.1 The installation work pertaining to this Contract shall include, but not be limited to the following:

a) Finalisation of the Construction and Installation Programme.

b) Survey on Site and review the technical requirements shown in this Specification and the Employer's Drawings.

c) Production of the calculation sheets and installation drawings for Site installation.

d) Installation in accordance with the finalized installation drawings.

e) Co-ordination with Other Contractors.

f) Submission of the installation reports and records.

g) Testing and commissioning, as per finalized protocol and programme.

h) Production of as built drawings, documents, calculation sheets, and records.

11.3 Construction and Installation Plan

11.3.1 The Contractor shall undertake installation work in stages as shown in the detailed installation programme to be submitted by Contractor. Installation, testing and commissioning of later stages shall not impact operation of earlier stages.

11.3.2 As a minimum, the detailed Construction and Installation Plan shall include but not be limited to all the activities described in this bid document and Employer's requirement - Construction and chapter on manufacturing, installation, testing and commissioning installation details and methods of all activities equipment and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for installation.

11.4 Material Handling

11.4.1 To provide for handling of consignments during construction and also needed during the life of the installation, the contractor shall provide an unloading gantry with a manually operated 5 tonne chain Pulley hoist on an unloading platform having the road approach of the switch yard in each Traction Substation as a part of the Permanent Works at his own cost.

11.5 Material Handling Plan for Equipment

11.5.1 The Contractor shall prepare a material handling plan for RSS,TSS, SSP and SP for movement and installation of bulky items such as transformers, 220kV, 132kV & 25kV switchgears and OHE Masts.

11.5.2 The Contractor shall comply with the requirements specified in of the GS (General Specification) in relation to the use of works sites allocated to the Contractor.

11.6 Temporary Works

11.6.1 The design of the Temporary Works shall be submitted to the Engineer for review. All Temporary Works shall be clearly distinguishable from the Permanent Works

11.6.2 All Temporary Works shall be removed on completion of the Section, or as directed by the Engineer.

11.7 Works Train

11.7.1 The Contractor shall provide adequate number of sets of High Output Works Trains/Rail cum road vehicles for construction of the OHE.

11.7.2 For the use of any Works Train/Rail-cum-road vehicle the Contractor shall ensure its safe loading, restraint against shifting while in motion and that the dimensions of materials and/or equipment carried. Under no circumstances, it shall infringe the

Schedule of moving dimensions stipulated for the Eastern Dedicated Freight Corridor as well as Indian Railways.

11.8 Site Supervision and Safety Issues

11.8.1 The Contractor shall set up a Site supervision system, which shall be part of the overall safety, system assurance and quality management system.

11.8.2 Quality Management

11.8.2.1 The Contractor shall adopt an appropriate quality management system throughout the entire Site installation period to ensure that the System performance requirements as specified in this PS are achieved.

11.8.2.2 The Contractor shall provide sufficient number of suitably experienced supervisors, skilled and licensed workers to ensure that the progress and quality of the work, both on Site and in the Contractor's workshop.

11.8.2.3 Supervisors shall have a minimum of **five years' previous experience** in a supervisory capacity on similar Projects and all the skilled workers including linesmen, electricians, fitters and craftsmen, shall have a minimum of two years previous experience in installation of similar systems. All skilled workers shall be trained and licensed by the contractor.

11.8.2.4 The Contractor's supervision system shall be responsible not only for the supervision of the concerned system installation but also for the supervision of the installation of the any fixing system (civil inserts), the Earth matt and duct systems etc.

11.8.2.5 The Contractor shall maintain a set of drawings at each Project site which accurately reflect the current status of field changes. The Contractor shall obtain letter of no objection from the Engineer for any such changes. The Contractor shall prepare final drawings showing the as built configuration. These drawings shall be developed in a logical format to facilitate routine system maintenance and troubleshooting. All drawings and details shall be endorsed by the Contractor.

11.8.2.6 The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractors staff, licensing and all associated documentation. Should any of the Contractors staff be found incompetent or unlicensed staff member shall be removed from the site until their Competency has been established. Where the staff are found to be unlicensed then the site shall be shut down until trained and licensed staff in sufficient numbers have assembled at site and have been fully briefed with respect to the method statement for the task and the safety arrangements. This provision shall not, in any manner, absolve the contractor of his responsibility in this regard.

11.9 Installation of Cables

11.9.1 The Contractor shall co-ordinate with the Civil Contractors for the installation of cables in cable trenches, ducts, troughs, risers and under track crossings.

11.9.2 The cable system shall, during installation, be fully protected from mechanical damage and be generally accessible at all designated points for inspection along its entire route. Suitable cable markers shall be provided for covered cables upon completion of installation.

11.9.3 Should it prove necessary to cut any cable during installation, all cut ends shall be properly sealed.

11.9.4 The maximum pulling force of any cable during installation shall not exceed the manufactures recommended design force of the cables.

11.9.5 All cables shall be installed in the formed cable trenches, shafts, under track crossings, hangers, trays and brackets. The minimum manufactures recommended bending radius of the cables shall not be exceeded during installation.

11.9.6 All materials used for termination, jointing and installation of cables in confined spaces shall have flame retardant, low smoke, halogen free characteristics.

11.9.7 Cables shall be placed in protective metallic conduits up to 1.5m above the ground.

11.10 Workmanship

11.10.1 Installation, construction and works shall be carried out following Good Engineering Practice and according to the instructions shown in this Specification, Employer's Drawings and the Contractors Approved Designs.

11.10.2 All assemblies of equipment and their components and parts shall be completely interchangeable if they are of similar function.

11.10.3 The Contractor shall pre assemble as much of the RSS, TSS, SSP and SP equipment in factory conditions as possible and deliver to site as pre tested modules.

11.10.4 The style and procedure of the workmanship shall be consistent throughout the Works.

11.10.5 All parts, which are subject to, wear or damage by dust, shall be completely enclosed in dust proof housings.

- END OF CHAPTER -

12. Training

12.1 General Requirements

12.1.1 The contractor shall provide comprehensive training to the Employer's Staff, including Employer's Trainers, in accordance with the requirements contained in this particular specification.

12.1.2 The contractor shall set up training class rooms at site, where he shall provide competent training instructors, training manuals, training simulators, all necessary aids and materials as required for all the training courses.

12.1.3 The contractor shall arrange training at such locations where the greatest benefits for trainees may be gained. Contractor shall train Employer's Personnel at OEM premises for all the equipment procured for the first time in India on Railways as per approved training plan. The contractor shall propose training at OEM premises/Work site where the technology/system is in use/work site of DFCIL. The cost of travel, lodging/boarding of trainees shall be borne by Employer while contractor shall bear the cost of arranging training/trainers at OEM premises/work sites.

12.1.4 All the training courses shall be conducted during installation period and completed before the commencement of testing and commissioning. No training course shall be started before the completion of Design phase.

12.1.5 The training shall be carried out as per training plan (para 12.6) & training period (para12.2) defined in this document.

12.1.6 The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possess good communication skills in English. The detailed CV of instructor should be submitted to Engineer for approval.

12.1.7 The training instructors shall be either the system designer or engineering staff of the contractor, the contractor's subcontractors or the equipment manufacturers.

12.1.8 The training courses and/or sessions shall include system performance requirements and all major equipment and works engineered by the Contractor. The training shall be in English.

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

12.1.10 The Contractor shall be required to arrange training to the Employer's staff in respect of design, installation, testing and commissioning of the System and each subsystem.

12.2 Training Period

12.2.1 Training in India shall be 180 training instructors' man days. The class size will be maximum of 30 trainees. Contractor shall bear all the cost for travel, lodging/boarding and Professional fee for the instructors. The cost of travel, lodging /boarding for trainees shall be borne by Employer.

12.3 Training Materials

12.3.1 At least two months before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides,

training manual for trainees, training aids and presentation materials to the Engineer for review. The training materials shall be prepared in a form to allow easy future reproduction.

12.3.2 The format of the trainer's guides and training manual for trainees shall be submitted to the Engineer for review.

12.3.3 The Contractor shall provide such written or printed matter, functional equipment, samples, models, cutaway equipment, slides, films and other instructional material, as may be necessary for training. Such equipment and material shall remain the property of the Employer and shall be sufficient both for the persons trained by the Contractor and for those to be subsequently trained by Employer Training Instructors.

12.3.4 The Contractor shall provide an instructor's guide for each training course. The guide shall include the course agenda, objectives, list of resources and facilities required, detailed lesson plans, presentation notes, discussion guides, training aids and job aids, test papers, criteria and methodology for testing and assessment, and all other things that will enable Employer's Training Instructors to carry out repeat or refresher courses in the future.

12.3.5 The Contractor shall, for each course, distribute two sets of trainer's guides, one set of training manual for each trainee, two sets of trainer's guides and three additional sets of training manual to the Engineer before the commencement of the training course.

12.3.6 All the training materials shall be accurate and match with the actual Design of the System.

12.4 Training Records

12.4.1 The Contractor shall devise a system, standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees. The system and standards shall be submitted to the Engineer for review four weeks before the commencement of the training course.

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 including attendees, trainer and training material

12.5 Course Evaluation

12.5.1 The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Engineer for review four weeks before the commencement of the training course.

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

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

12.5.4 The contractor shall submit the course evaluation criteria to the Engineer for approval.

12.6 Training Plan

12.6.1 Within 120 days after the commencement date of the works, the contractor shall submit a training plan to the Engineer for review.

12.6.2 The training plan shall include, but not be limited to, the following:

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

(b) Overview and description of objectives of each training course.

(c) The location where the training course to be conducted.

(d) Setups for practical exercises.

(e) The contractor's training organization chart, including the role and responsibilities of individual key persons;

(f) The qualifications and experience of the training instructors; and

(g) Details of training simulators to be provided or developed, if applicable.

12.7 Training Courses

12.7.1 The contractor shall provide training courses for each of the Subsystems, including, but not be limited to:

- 2x25 kV OHE system
- SCOTT Connected Transformer and auto transformer
- RSS
- TSS
- SP/SSP
- TCP/IP Based SCADA System
- Advanced numerical relay based protection system
- 11Kv/440V Transformer, DG set, HT & LT panels
- All systems/sub-systems proposed for electrification in this contract.

12.7.2 Different types of training courses of each subsystem shall be provided for staff from different disciplines. Operations training courses shall be provided for the operations staff, system engineering and maintenance courses shall be provided for engineering and maintenance staff. The employer's training instructors shall attend all types of training courses such that the employer's training shall be able to subsequently train the employer's staff in all aspects of operation and maintenance of the system

12.7.3 The contractor shall determine the number of classes for each type of training course to ensure the objectives of the course can be met.

12.7.4 **Operation and Troubleshooting Training Courses:**

12.7.4.1 The operation and troubleshooting course shall be developed to provide all necessary knowledge and skills for operations staff of the Employer to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the training course shall include the following as minimum:

1) Overview of the Telecommunication system;
2) Brief description of the operation principle of the subsystem;
3) Operational features and functions;

4) Familiarization and use of all man-machine interfaces involved;
5) Reading and interpretation of system status and alarm messages or indications;
6) Normal operating procedures;
7) Operating procedures under emergency situations;
8) Procedures for recovery from minor or simple faults; and
9) Use of operation and maintenance manuals and documentation.

12.7.4.2 Particular exercises shall be included in the operations training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple faults recovery.

12.7.5 **System Engineering Course**

12.7.5.1 The system engineering courses shall be developed to provide all necessary knowledge and skills:

1) To perform system engineering management including system parameter configuration, enhancement, expansion and provision of new circuits; and
2) To perform full maintenance, including both preventive and corrective maintenance, on the system.

12.7.5.2 The contractor shall determine the content of the courses and the courses shall include the following as minimum:

1) overview of the Telecommunications System;
2) background theory
3) system features and functions;
4) system configuration and operation principles;
5) description of system component and equipment down to card or module level;
6) test and commissioning procedures;
7) use of test equipment and special tools;
8) reading and interpretation of alarm indications, message and print-outs;
9) preventive maintenance procedures;
10) fault diagnosis, troubleshooting and corrective maintenance procedures;
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; and
14) use of software such as peripheral control and configuration, utility, database structure, generation and modification.

12.7.5.3 Practical exercise shall be provided for each trainee to practice the following as minimum.

1) Use of test equipment and special tools;
2) Preventive maintenance;

3) Fault simulation, fault diagnosis and troubleshooting with induced faults set by the contractor to simulate real - life situation; and

4) Procedures for attending/restoration of system to healthy state.

- END OF THE CHAPTER -

13 Non Traction Power Supply and Distribution System

13.1 General Electrical Specification

13.1.1 Introduction

This Specification defines the objectives, guidelines and requirements for Design, Supply, Installation, Testing and Commissioning of Electrical System which includes Switching Stations, LT Substation, Solar Power system, UPS, Fire detection, alarm system, DG Set, Auxiliary SCADA, Provision of maintenance & operation manuals and training of staff. The details of works to be carried out by the Contractor are enlisted in the Interface Matrix (for Non-Traction Power Supply System) is given in Annexure – XI.

This section of the Specification has been prepared based on the conceptual design. However, the *Contractor* shall satisfy himself that the proposed designs, capacities, ratings, specifications and quantities of equipment are adequate to meet the functional, operational and performance requirements of the complete system.

For Non-traction power supply and distribution system, Buildings in the project and E&M facilities at a glance are given in Appendix 3 (Design and construction interfaces) of Part 2: General Specification.

13.1.2 Responsibility of the Contractor

The Contractor shall be responsible for design, manufacture, supply, installation, testing & commissioning (including integrated testing & commissioning), trial running, supply of Contract Spares, O&M Manuals, training, As Built Documentation, coordination with Other Contractors and compliance of other Statuary obligations.

13.1.3 General Requirement

(1) Design Performance & Criteria

The basic design criteria for non-traction power supply and distribution system shall be based on NEC 2011, NBC 2005 and ECBC 2007.

a) Major Parameters

i. Power Supply System

a. Incoming supply to the Sub-Station shall be obtained at 11 kV from SEB to the 11 kV Sub-Station of DFC through HT UG Cable.

Availability of Non Traction Power Supply of SEB			
SN	Name of Station	Approx. Distance at 11 kV supply available in km	Crossing Required
1	New Sonnagar	0.5	Nil
2	New Ganjkhwaja	2.0	IR Track and DFC Track

b. The power supply system shall consist of TPN, 415V, 3 phase, 50Hz, 4-wire, commencing from Local Utility incoming feed at 11kV.

c. The power supply system shall include construction of electrical substation, HT/LT Switchgear, Main Distribution Board, supply and distribution panel for the operation of the entire premises.

d. The Sub-station shall have one step down transformer of adequate capacity.

e. The electrical substation shall be designed to feed the supply power to Stations and its Utility Buildings, street light, pumping installation, staff quarters etc. as applicable.

f. Important switchgear shall be designed with 100% redundancy.

g. All the electrical panels shall have fire trace tube type extinguishers to detect and extinguish the fire. Separate portable fire extinguishers shall also be provided as per requirement.

h. This shall be provided in a secure building having adequate space, fully ventilated and weatherproof.

ii. Power Supply Arrangement

a. The concept plan for Non-Traction Power Distribution System for New Sonnagar and New Ganjkhwaja is enclosed as **Attachment – 13.1.**

b. The electrical power for the station load shall be derived from the following sources:

- Local utility Main feed at 11kV.
- DG Set with Auto Mains Failure (AMF) Panel, as stand by.
- Solar Power system
- UPS

c. The UPS shall be designed to meet the requirement of essential load e.g. emergency lighting, fannage, fire detection system, supply to computers etc.

d. Solar panel will be grid-tied connected system.

e. DG Set shall be designed to meet all essential loads including pumping, fannage, security lighting, 30% lighting circuits, signaling and telecommunication system at stations and supply to computers.

iii. Metering Requirements

a. Total; domestic, service building, pumping installation, street lights, Operational Demands should be metered separately.

b. Metering for tariff purposes should be provided for different types of load as required by Power Supply Authority.

b) Basic Design Philosophy

i. The design philosophy shall meet the following criteria:

a. Application of the latest code of practice and standards.
b. Service Proven design.
c. Minimum life cycle cost.
d. Low maintenance cost and ease of maintainability.
e. Use of interchangeability.
f. Extensive and prominent labeling of parts, cables and wires.
g. Use of unique serial numbers for traceability of components.
h. High reliability and availability of parts & spares

i. Low energy loss; use of at least 3 star or higher rated, if available, electrical equipments.
j. System safety.
k. Adequate redundancy in system.
l. Use of fire retardant materials.
m. Environment friendly.
n. Adherence to operational performance requirements.
o. Energy conservation features.
p. Adequate margin shall be built into the design particularly to take care of the higher ambient temperatures, dusty conditions and high seasonal monsoon humidity, salinity etc. prevailing in Eastern and Northern India.

ii. Proven Design for Non-Traction System

a. The Contractor shall develop the design based on these Specifications. The design details shall be submitted with technical data/product catalogue and calculations to the Engineer for his 'NO Objection Certificate'.

b. The proposed system/equipment to be used should be of Proven performance and should have been satisfactorily in use in adequate numbers (at least 70% of the estimated quantities) in Metro Rail, Railways or Airports during the last 3 years prior to date of tender opening of this project work. The Contractor shall submit necessary documentary proof in this regard.

c. Complete technical & operational information shall be included in the proposal for all major components together with service history & performance details, number of units in use etc. identities of users with addresses, telephone & fax. Number etc. for reference purpose.

d. Energy efficient, fittings/fixtures of reputed manufacturer shall be considered.

e. Where similar equipment or sub-systems of a higher rating are already Proven in service, then the design shall be based on such equipment. Notwithstanding the fulfillment of the above stipulations, the Contractor shall furnish sufficient information to prove the basic soundness energy efficiency and reliability of the offered sub-system to the Engineer, for the approval.

(2) Design and Control

a) The basic design shall be as per National Building Code, ECBC Code and NFPA.
b) The safety of installation shall comply with the provisions of the Indian Electricity Rule, IEEE-80 and IS standards.
c) All LT and HT works up to 11KV shall be done by underground cable laying maintaining route and space diversity.
d) The work shall be carried out in accordance with drawings, specifications and ensuring compliance with design and performance requirements.
e) Provision of Solar Power and UPS at Stations. Contractor shall assist Employer in seeking assistance from subsidies by the Govt. of India.
f) Table indicating controls and monitoring aspects shall be submitted by the Contractor.

g) All Safety systems, panel and Earthing shall use materials as per the relevant standards.

h) Earthing schedule.

i) Battery backup for 2hrs is required for Essential Loads.

j) Order of priority for automatic changeover for S&T supply and Station load.

k) Power cables shall be rated such that the maximum voltage drop from supply point to the farthest point on any power supply feeder shall not exceed 7% of the supply voltage under maximum loading conditions.

l) The main and emergency circuit shall be designed with 100% redundancy.

m) All SDBs shall be designed with dual incomers for 100% redundancy.

n) Automatic Power Factor Correction Panel shall be designed to achieve power factor of 0.92 & above.

o) Equipment shall comply IP 53 for Indoor and IP 54 for outdoor application.

13.1.4 Load Requirement and Emergency Power for DG Set

(1) Total load for S&T may be taken as minimum 10KVA for each Junction and Crossing Stations.

(2) Lighting including Security Light, Critical fannage, Fire detection and Ventilation, Pumps, Computers, Signage load and all other installation included in the concept plan shall be connected to Emergency Power considering the 30% of the total load of that installation.

(3) Power Supply Arrangement for S&T /Other Installations is shown in **Attachment – 13.2** to this Specification.

13.1.5 Provision of appliances/equipment

(1) The Contractor shall provide appliances/equipment at Stations viz. water coolers, ceiling fan, air conditioners etc. as specified in Attachment 13.3.

(2) Air conditioner shall be provided at the following installations:

- In the Station masters/ASM room, Signalling& Telecom equipment rooms, Relay Room, OFC room at stations/cabin.
- Officer rest room at stations (New Sonnagar only)

(3) **Ventilation requirement:** In IPS & Data Logger Equipment room and its Battery room, Relay room and Panel room/Rest room. Telecomm (OFC) Room and its power supply and battery room.

13.1.6 Corrosion Protection

All ferrous components and fittings exposed to the atmosphere shall be hot-dip galvanized as per the relevant IS.

13.1.7 Acoustic Criteria

Noise emanating from the equipment/service installations shall not exceed 55 dB for the static machines and 65 dB for rotating machinery at a distance of one meter to match or exceed the relevant International Standards for each of the equipment.

13.1.8 **Colour Coding**

(1) Colour coding for power cables, busbars shall be as follow:

Phase R	Red
Phase Y	Yellow
Phase B	Blue
Neutral	Black
Ground	Green or Yellow strip

Large wires and cables shall also be colour coded with tapes as specific colour.

(2) Colour coding for Junction boxes shall be as follow:

Normal Power	Orange
Essential power	Yellow
Telephone system	Green
Fire alarm System	Red
Control System	Blue

13.1.9 **Drawings and Documents**

a) Foundation & Layout Drawings for all installation shall be submitted.

b) Outline Dimensions of all Equipment shall be submitted.

c) Copies of Instruction Manuals/Operation and Maintenance Manuals.

13.1.10 **Submittal from Contractor**

a) Design Documents, including rating of equipment, load flow analysis and voltage drop calculations.

b) Protection Study including earthing & bonding, lightning protection and Touch Potential.

c) Inspection and Testing Protocol.

d) Cable Section Calculations.

e) Wiring Layout and cable rout plan

f) As installed drawings and layout.

g) Operating and Maintenance Manuals.

h) Wiring Code for Building and Detail Specifications of Major Equipment.

i) Earthing and Bonding schedule.

13.1.11 **Painting of Panels**

a) All metal surfaces of panels, e.g. switchgears, switchboards, DB boards, etc. shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid.

b) The panels shall be spray painted with two coats of final paint. Colour shade of final paint shall be RAL 7032 (epoxy based). The finished panel shall be dried in oven in dust free atmosphere. Panel finish shall be free from imperfection like pin holes, orange peels, run off paint, etc. The vendor shall furnish painting procedure details along with the drawing submission. The minimum painting thickness shall be 80 microns.

13.2 Electrical System

13.2.1 Scope of Work

a) The scope of work under the Contract includes design, manufacture, delivery, installation, testing and commissioning (including integrated testing and commissioning), trial runs of the Electrical System but not limited to the following electrical installation:

- Incoming Supply Metering.
- HT/LT Switchgear.
- LT Distribution Transformer.
- HT/LT Cable and cable laying
- Signage.
- SCADA for Auxiliary Power Supply.
- Solar Panel at Stations and TSS only.
- Lighting arrangement of circulating area at station (New Sonnagar and New Ganjkhwaja)
- Automatic Power Factor Capacitor Panel.
- Diesel Generator Set (DG) with AMF panel.
- UPS
- Earthing, Bonding and Lightning Protection System.
- Cable Sealing System.
- Fire Detection and Alarm System including fire extinguishers.
- Co-ordination, liaisoning / pursuing with State Electricity Authorities for availing new Electric connection / augmentation of load etc.
- Operation & Maintenance Manuals and other related Documentation.
- As Built Drawings and Documentation.
- Training for the Employer's Operation and Maintenance staff.
- Miscellaneous items e.g. shock treatment charts, sectioning layouts, safety rubber mats, equipment number plates, first aid boxes and danger notice plates etc.

13.2.2 General Requirements

(1) The work shall be carried out by the Contractor having valid Electrical Contractor License issued by the State Government for carrying out electrical installation work, by employing licensed supervisors and skilled workers having valid permits as per the CEA Regulations, 2010 and Local Electrical Inspector's requirements.

(2) The successful Bidder shall furnish the copy of the valid & attested Electrical Contractor License including names and particular of the certificate of competency of its supervisor and workmen to be engaged for carrying out the work.

(3) Whether specifically mentioned or not in this specification, the work shall be deemed to include all the related minor works / items as appropriate but not limited to hardware items, foundation bolts, termination lugs for electrical connections etc. as required and necessary for proper working of the equipment / system. If any activity of the work is considered to be essential for meeting the functional requirements of the equipment / system and satisfactory completion of the work but is not mentioned / specified herein or elsewhere in the Documents, the same shall be deemed to be included in the Scope of Works and shall be executed by the Contractor within the accepted Bid Price.

(4) It shall be the responsibility of the Contract*or* to provide a completely safe and workable system in accordance with the requirements of the relevant standards, the accompanying drawings and schedules to the satisfaction of Employer.

(5) The *Contractor* shall coordinate with the other Contractors linked with this Project to ensure that the system and its components furnished shall form a complete electrical system with the established construction schedule.

(6) For each main power supply points, The Contractor shall give the following details:

a) The estimated maximum continuous load; and

b) The estimated maximum peak load and its duration.

These values shall be ratified by the Contractor at the systems design stage. The *Contractor* shall be responsible for liasoning and co-coordinating with various power supply utilities for obtaining necessary power supply connection at the required locations and obtain clearance for the Electrical Inspector of the area.

(7) The Contractor shall also provide all the energy efficient luminaries including lamps of the approved make and lux level as required and approved by the Engineer.

(8) All major equipment and materials such as LT Switchgear, Distribution / sub-distribution Boards, Switchboards, Battery, UPS, Battery Chargers, Change-over Switches, , Signage, PVC/ XLPE Cables, etc. as required for the work shall be subject to Quality Assurance Programme as approved by the Engineer to ensure proper supply and use of raw materials, processes, installation / execution and tests.

(9) The Contractor shall furnish the Quality Assurance Programme prior to fabrication of various assemblies and their supplies for installation. A well-documented quality plan shall be charted indicating all the activities and interfaces relating to the sustained check on quality of workmanship and materials used in various stages of work.

13.2.3 Metering Requirements : based on Tariff and distribution

a.) Main meters or Check Meters for Tariff purposes should be provided for different types of load as required by Power Supply Authority.

b.) All major three phase outlets shall have meters which will be used for measurement of energy used and control function.

c.) All energy meters shall exchange data through appropriate communication port and shall be able to be integrated with SCADA requirements as per **Attachment 13.4.**

13.2.4 Safety in the Equipment

Safety items in the substation shall include the required type and number of the equipment as calculated from Design and Employer's Requirements and Concept Plan. The Sub-station and Panel Rooms shall be equipped with earthing/ safety mats.

13.3 11 KV Switchgear

13.3.1 Scope

This section of the Specifications covers the design, manufacture, type and routine tests and delivery of indoor HV Switchgear of 11kV voltage rating. The equipment to be offered under this specification shall be of proven design. Further, the switchgear must have been type tested in the same configuration that has been offered.

13.3.2 **Construction**

(1) The switchgear unit shall be designed, manufactured and tested in accordance with relevant Indian Standard Specifications. The panels shall be indoor/ outdoor, metal enclosed, epoxy coated, having circuit breaker with fully draw out type design. The bus bars and cable chambers shall be housed in a separate chambers.

(2) The bus bar and cable chambers shall be fitted with bolted covers with gaskets and should be fixed to avoid direct access to live parts immediately after opening the respective covers. The bus bars and jumper connections shall be insulated to maximum operating voltage. The design of panel board shall permit further extension at both ends. The panel board shall be designed for IP54 protection.

(3) The HV Panel board shall be designed in such a manner that the switchgear, instruments, relays, bus bars, small wiring, etc. are arranged & mounted with due consideration for the following;

a) Facility for inspection, maintenance & repairs of testing terminals and terminal boards for ease of external connection.
b) Risk of accidental short circuit & open circuit.
c) Secured & vibration proof connections for power & control circuits.
d) Risk of accidental contact & danger to Personnel due to live parts.
e) Future expansion.

(4) Enclosure shall be CRCA sheet steel minimum 3.0mm thick.

(5) Panel shall conform to IEC 61439.

(6) Internal wiring shall be with HRFR/FRLS, halogen free wire.

(7) Indicators shall be LED type.

(8) PU foamed gaskets for doors (100% CFC free).

(9) Breaker shall be VCB.

(10) Anti-condensation space heaters.

(11) CT & PT shall be epoxy resin type with accuracy class as per relevant IS.

(12) Low Maintenance Battery backup for tripping & auto reclosing of breakers.

(13) Digital metering with RS 485 port, for download and diagnostics.

(14) Energy monitoring system on the incomers with class-1 accuracy.

(15) Bus bars 100% electrolytic copper as per the relevant standards.

(16) Bus bar support shall be insulated with colour coded, heat shrinkable PVC sleeves & shrouded joints.

(17) Sheet treatment with nano-ceramic coating, electro-dip coated primer with textured Epoxy polyester. Powder coating thickness shall be 80-135 micron.

(18) The bus bars shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding the total temperature of 85°C.

(19) The bus bars and their connections shall be capable of withstanding, without damage, the thermal and mechanical effects of through Fault Current equivalent to the short circuit time rating of the switchgear.

(20) Relay and protection system at HV and LV side shall be provided.

13.3.3 **Safety Shutter Devices**

(1) A set of metallic shutters shall be provided to cover each 3-phase group of stationary isolating contacts. Each set shall be capable of being individually operated and individually padlock closed.

(2) The shutter shall open automatically by a positive drive initiated by the movement of the circuit breaker.

(3) The closing operation shall be automatic, either by positive drive or by two independent.

(4) All shutters shall be effectively Earthed.

13.3.4 **Insulators**

(1) Insulators shall be as per IS: 743.

(2) Insulators shall be mounted on the switchgear structure such that there is no likelihood of their being mechanically over-stressed, during normal tightening of the mounting and bus bars, connection, etc.

13.3.5 **Circuit Breaker General Requirements**

(1) The circuit breaker shall be capable of making and breaking the specified Fault Currents without straining or damaging any part of the switchgear.

(2) It shall also be capable of closing on no-load without suffering undue mechanical deterioration. The maximum make-time also should not be exceeded.

(3) Means shall be provided for electrical/manual closing and tripping of breaker either from local or remote mode. Further local-manual, mechanical tripping of circuit breakers, preferably by push buttons shrouded to prevent inadvertent operation shall be provided.

(4) It shall not be possible to render the electrical tripping feature inoperative by any mechanical locking device.

(5) The breaker operating mechanism shall be electrically and mechanically trip-free in all positions. The breaker should also be provided with both mechanical and electrical anti-pumping devices.

13.3.6 **Vacuum Circuit Breakers**

(1) They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism. Breakers shall be suitable for switching transformer at any load.

(2) Uni-polar over-voltage at circuit breaker terminal shall not exceed two and a half times nominal peak line to neutral voltage of the system while switching ON/OFF at any load.

13.3.7 **Nameplates and Identification**

Suitable anodized Aluminium name plate of 3mm thick shall be provided on the switchboard and individual panels with all necessary information.

13.3.8 **Cable Boxes / Cable Chamber**

(1) Cable boxes / cable chamber shall be suitable for the type and size of cable specified. The position of the cable boxes shall be such that the cables can be safely taken and the jointing carried out in a convenient and satisfactory manner. The cable termination arrangement for multiple cables shall permit connection and disconnection of individual cables without disturbing the other cables.

13.4 LT Distribution Transformer

13.4.1 **Scope**

(1) The transformer shall be 63 KVA copper wound, oil cooled, Dyn 11 as per IS: 2026 with latest amendments. The transformer shall be suitable for outdoor use and shall have protection IP 54. Transformer shall be BEE star rated as applicable.

(2) The transformer shall be provided complete with accessories e.g. conservator, off load tap changer, silica gel breather, winding/oil temp indicators, explosion vent, rollers etc.

(3) Some of the desired parameters are as under:

a) Cooling- ONAN with new insulating oil as per IS 335.

b) Tap changer- off load = 2.5% to -7.5% in step of 2.5%

c) % impedance – less than 5%

d) Core material - CRGO

e) Maximum Temperature rise above ambient temp of 50 ^{0}C

- Winding by resistance method – 40 ^{0}C
- Oil by thermometer – 35 ^{0}C

f) No load current with normal voltage – less than 2%

(4) Transformer tank welding shall be as per relevant ASME standards.

(5) Lifting/pulling hooks shall be minimum 8mm thick (MS).

(6) Minimum 6mm Neoprene bonded cork gaskets conforming to IS 4253 Part-II.

(7) External paint shall be oil & weather resistant. Inner surface shall have heat resistant paint.

(8) All winding joints shall be by brazing only.

13.4.2 **Performance**

(1) Rise in temperature of transformer when tested at continuous maximum rating at a peak ambient temperature of 50ºC, shall not exceed the limits given below:

(2) For Windings - Average temperature rise as measured by increase in resistance of windings connected between terminals shall not exceed 55ºC.

(3) For Oil - Temperature rise as measured by thermometer in oil of the transformer shall not exceed 50ºC.

(4) For cores - Temperature rise when measured by thermometer on the external surface of core shall not exceed the temperature permitted as per the relevant IS.

13.4.3 **Impulse Strength of Windings**

The impulse strength of windings of the transformer shall meet the requirements of relevant IS. The transformer shall have fully insulated windings designed to meet impulse levels.

13.4.4 **Frequency**

The transformer shall be designed for a normal frequency of 50 Hz and shall be capable of giving the rated output with the frequency varying by plus or minus 3% from rated frequency.

13.4.5 **External Short Circuits**

The transformer shall be designed to be capable of withstanding without damage, the thermal and mechanical effects of short circuit at the terminals or any winding for the period in accordance with relevant IS.

13.4.6 **Efficiency and Regulation**

Efficiency and regulation shall be based on loading at rated KVA and at unity power factor and 0.8 lagging power factor and shall be computed in accordance with IS.

13.4.7 **Foundation and Fencing for Transformer**

A suitable foundation /gantry and fencing shall be designed and provided by the Contractor and to be approved by the Engineer.

13.4.8 Anti-Climbing Devices and Danger Notice Plate shall be provided.

13.4.9 **Clearances**

The electrical clearances shall be maintained as per I.E. regulations. The design of the transformer shall be chosen /carried out considering the electrical clearances as per the relevant standards.

13.4.10 **Type Test and Acceptance Test**

(1) The Contractor shall furnish the reports of all type tests carried out as per IS: 2026 (Part I). Type test certificates and a copy of the short circuit test conforming to IS: 2026 (Part I) successfully carried out on similar type of transformer shall be submitted without which transformer shall not be considered for acceptance.

(2) Routine Tests – Tests as per IS: 2026 (Part I) shall be witnessed by the Engineer or employers representative at the manufacturer's works.

13.4.11 **Testing at Site**

Prior to commissioning of the transformer, the following tests shall be performed and jointly signed by the contractor and the Engineer:

a) Insulation Resistance.
b) Winding Resistance.
c) Dielectric Strength.
d) Input Power Supply.
e) Output Voltage.

13.4.12 **Acceptance / Rejection Parameters**

Sl. No.	Relevant IS Code and Clause No. (latest versions)	Acceptance limit
1.	IS : 2026 (Part I), Clause no. 4.3.1 (Operation other than rated voltage)	Limits within ± 10% of rated voltage of particular tapping
2.	IS : 2026 (Part II), Clause no. 3.2 (Temperature Rise)	Limits as specified in Clause no. 3.2 of IS : 2026 (Part II),
3.	IS : 2026 (Part I), Table 3 (Impedance Voltage)	a) 4.5% upto 630kVA b) 5% above 630kVA and upto including 1000kVA
4.	IS : 2026 (Part I), Clause no. 8.1.6 (Tap Changing Equipment)	Limits as specified in Clause no. 3.2 of IS : 2026 (Part II),
5.	IS : 2026 (Part I), Clause no. 9.1.3 (Duration of Symmetrical Short Circuit Current)	2 Seconds (max)
6.	IS : 2026 (Part I), Table 7 (Tolerances)	As specified in Table 7 of IS: 2026

13.5 HT Cable

13.5.1 Scope

(1) All power cables shall be rated at 11kV for armoured cables.

(2) PVC/rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

(3) All cables rated 11kV and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semi-conducting shielding.

(4) Cables shall be heavy-duty type; 11kV grade with aluminum conductor, XLPE insulated, overall PVC sheathed, armoured and screened.

13.5.2 Cable Accessories

Jointing Kits: The straight joint through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals.

13.5.3 Type test should be conducted if not carried out in last 5 years by any Railway/Metro Railway/any other Client.

13.6 LT Cable

13.6.1 Scope

1) All LT and auxiliary/control cables shall be rated at 600/1100 V for armoured and unarmoured cables.
2) XLPE insulated cables shall be rated for continuous operation at a maximum conductor temperature of 90°C and for a maximum short circuit temperature of 250° C.
3) Main cables of cross-sectional area of 25 sq.mm and above shall be of 4 core Aluminium and cables of less than 25 sq. mm. shall be of 4 core copper conductor.
4) Emergency and fire survival circuits shall be of FRLS cables and other cables may be XLPE.
5) Circuits shall be designed such that the voltage drop at the extreme end shall be less than 7%.
6) In case the cable is to be laid in trench, the trench shall be back filled with dry sand up to 300mm above cable after laying. On transformer side the cable shall be held with “U” frame manufactured with MS angle 50x50x6 mm & grouted vertical in floor. Cable shall be held vertical with clamps of MS flat 50x6 mm at two places on frame on transformer side.
7) Cables wiring from service transformer to Main LV Switchboard shall be FRLS, XLPE insulated armoured cables or as indicated on the drawings.
8) Cable wiring for Control circuits and interfacing shall be 1100V FRLS/ XLPE insulated cables, with/or without shields.

13.6.2 Component

1) PVC Insulated Cable

Low voltage cables shall be copper conductors ST2 insulated, PVC sheathed with flame retardant low smoke (FRLS) compound and armoured conforming to IS:1554 Part-I. Cables shall be rated for 1100 Volts. Conductors shall be insulated with high quality PVC base compound.

2) XLPE Cable

The cables shall be 1100 Volt grade XLPE insulated with PVC inner sheath steel armoured/ unarmoured and with an outer protective sheath of flame retardant low smoke (FRLS) compound, conforming to IS: 7098 (Part I) as indicated above.

3) Fire Resistant Cable (FR) for Fire Alarm and Safety Circuits only

a. Fire Resistant Cable (FR) with the cable size of 6 sq. mm. or less, or branch circuit wire such as emergency, life safety circuits, shall be single sheathed and installed in GI - conduit.

b. Conductor shall be stranded plain annealed copper wires, over the conductor, the mica tape shall be applied as the fire barrier tape.

c. Insulation shall be low smoke & zero halogen LSZH cross-linked polyethylene (LSHF - XLPE) thermosetting compound conforming to BS 7846.

d. These cables shall be resistant to flame temperature of 950ºC for 3 hour minimum.

e. Cables shall not generate hazardous, corrosive gases when burnt.

4) Control Cable

a) All control cable shall be suitable for installation in wet and dry locations. The conductor shall be of soft or annealed stranded uncoated copper wire.

b) The cable shall be helically wrapped over the filler and copper shielding with non-hygroscopic Mylar or Polyester tape.

c) The shielding, for control cables, shall be annealed aluminium tape or suitable width and shall be helically applied with a minimum 10% lap. The annealed aluminium tape shall be at least 0.1mm thickness and substantially free from burrs.

13.6.3 Cable Accessories

1) Termination Kits: The termination kits shall be suitable for termination of the cables to indoor switchgear or to a transformer/motor.

2) Jointing Kits: The straight through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals.

3) Installation: In general, the LT cables shall be run in conduits, in cable tray and shall be run concealed in ceiling, floor, and wall or as indicated on the Drawings.

13.6.4 Testing and Commissioning

1) The cables shall be meggered phase-to-phase and phase- to-ground before the equipment is connected and phase-to-ground after the equipment is connected and all connections are taped.

2) Insulation resistance tests shall be performed by using a 500 V, DC megger on the 400 volts system. Insulation resistance shall be not less than 50 mega-ohms per 1000 volts rating.

3) Wiring Continuity Test: All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.

13.7 LT Switchgear

13.7.1 Scope

This section of the Specifications covers the design, manufacture, type and routine tests, delivery and installation & commissioning of indoor LT Switchgear, complete with bus connections, incoming& feeder circuit breakers/MCCB, and busbars for distributing power to a 415/230V, 3-phase, 50Hz, 4-wires, solidly grounded neutral system with

interconnections, metering, protection and earthing. The *Contractor* shall supply and install the main low voltage switchboard, distribution boards, capacitor bank and its accessories as described or indicated in the concept plan or on the Drawings and specified herein. The switch gear panel shall be designed, manufactured and tested in accordance with IEC 61439.

13.7.2 Construction Requirements

1) General

a) The switchgear panel shall be indoor type, metal enclosed, single front and free standing type. All switch, fuse, Moulded Case Circuit Breakers, and feeders shall be in fully compartmentalized fixed/draw out design. The sheet steel (CRCA) used for fabrication shall be of 1.6mm for non-load bearing member and 2.0mm for load bearing members. The panel shall be supplied with required base channels. The insulators shall be made of high epoxy resin moulding. The bus bars and cable chambers shall be housed in separate chambers.

b) The bus bar and cable chambers should be fitted with bolted covers with gaskets and should be shrouded to avoid direct access to live parts immediately after opening of the respective covers. The bus bars and jumper connections shall be insulated to full maximum operating voltage. The panel shall be designed for IP 53 protection. The busbars and connectors shall be made of high conductivity Aluminium. The busbars shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding the total temperature of 85^{o}C. Unless otherwise stated, the entire busbar shall be rated for the continuous rated current of the incomer. When sectionalized with a bus coupler, both the busbars shall be of the same rating.

c) Outgoing feeders shall have energy monitoring facility

d) Microprocessor based MCCB as incomers with BMS connectivity features

e) MCCB/SFU for outgoing feeders. Separate compartments for functional units

f) Elect./Mech. interlocking between MCCBs

g) Sheet treatment with nano-ceramic coating, electro-dip coated primer with textured polyester. Powder coating thickness shall be 80-135 micron. Epoxy Polyester powder for indoor application & pure Polyester powder with Tri GlycidylIso Cyanurate (TGIC) for all weather applications. Shade RAL 7032.

h) Doors shall be flush type, 2.0 mm minimum CRCA sheet thickness. Screw fastened hinges. Minimum 130 deg opening angle. Cam lock with double bit insert. Separate doors for each compartment duly interlocked with the MCCB/SFU in “ON” & “OFF” position.

i) Sealing gasket shall be tri-functional CFC free polyurethane gasket with temperature withstand range of -40deg to 90 deg, non-hygroscopic in nature. Gasket should conform to DIN EN ISO 1856 & 1798 & compressive strength as per DIN 53 577, tensile strength as per DIN 53 504.

2) Safety Shutter Device

Shutters shall be provided at bus bar chamber cut-out for closing the same when the withdrawal chassis of the modules are drawn out. The bus bar shutters shall be automatically operated by the movement of the carriage.

3) Insulators

Insulator as per IEC-60815 may be adopted for different pollution level.

4) Fast Bus Changeover

Automatic Fast changeover scheme between incomers and the tie will be provided to close when incomer trips are initiated. The signal will be given to the bus tie closing coil and incomer breaker tripping time and bus tie breaker closing time will be around 20 millisecond. The closing of the bus couplers will be done through synchro-check relays. The synchro-check relay will be supplied from the secondary's of the two Bus PTs. This dedicated synchro-check relay will be located on the switchgear. The transfer will be blocked in case of fault in switchgear bus.

5) Moulded Case Circuit Breaker (MCCB)

a) The MCCBs shall conform to the latest applicable standards.
b) The breaking capacity of MCCBs shall be as per design requirements.
c) MCCBs shall conform to IEC 60947. MCCB shall be with Earth fault and over current microprocessor release. SFU shall be under 32A utilization category.

6) Miniature Circuit Breakers (MCB)

Miniature circuit breakers shall conform to the latest applicable standards. The MCB shall be trip-free, quick make and break type for 230/415V, AC, 50 HZ application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415V, AC. MCBs shall be DIN mounted. The MCB shall be current limiting type (Class-3). MCBs shall be classified (B, C, D with relevant IS Standard) as per their Tripping Characteristic curves defined by the manufacturer.

7) Earth Leakage Circuit Breaker (ELCB)

ELCB/RCCB/RCBO shall be current operated independent of the line voltage, current sensitivity of a minimum 30 mA and a maximum of 300 mA at 230/415V, AC and shall have a minimum of 20,000 electrical operations.

8) Neutral Advance Features

The neutral moving contacts shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact, first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulation.

9) Current Transformers

All current transformers shall have insulation level and short time rating as per main switchgear. All current transformers shall be dimensioned to carry continuously a current of 120% of the rated current. The ratio shall be as per design requirement.

10) Voltage/Potential Transformer

a) The Voltage transformer shall be insulated for maximum operating voltage.
b) PT shall be capable of withstanding thermal and mechanical stresses resulting from short circuit and momentary current rating of breaker/switches.

11) Relays and Other Accessories

a) All relays shall be of switchboard pattern, back connected, draw out type suitable for flush mounting and fitted with dust tight cases and provided with flag indicators and hand reset devices. The relay shall conform to the relevant IS. Relays shall be provided with hand reset type contacts. The rating of the auxiliary contacts shall not be less than 10A at 230V AC and 5A for 110V DC.
b) Each incomer / feeder shall be equipped with relays as per design requirement.
c) All relays shall have the following features:
   i) Shall be suitable for auxiliary supply, as per design requirement.
   ii) Shall be of draw out type suitable for flush mounting.
   iii) All auxiliary relays shall be of semi-flush or surface mounting.

12) Indicating Lamps / Push Buttons

a) These shall be switchboard type, low power consumption, LED cluster type lamps complete with necessary accessories. Lamps shall be provided with screwed translucent covers to diffuse light. The lamp covers shall preferably be unbreakable, moulded, heat resistant material and shall be provided with chromium plated bezels.

b) Push buttons shall be of heavy duty, push to actuate type with coloured button and inscription marked with its function. Each push button shall have contacts as required, rated with 10A at operating voltage.

Push button shall be shrouded type except for emergency trip button (if provided) which shall be mushroom type for easy identification. Push button colour shall be as follows;

i) Stop/Off - Red
ii) Start/On - Green
iii) Reset - Yellow
iv) Test - Black

c) Control Switches / Selector Switches

i) Control and meter selection switches shall have integral nameplate and for all other devices, the same shall be located below the respective devices.

ii) Instrument and devices mounted on the face of the panels shall also be identified on the rear with the same number.

iii) All control switches shall be rotary, back connected type. Phosphor bronze contacts shall be used on switches.

iv) Control switch for incomer panels shall have one set of lost-motion spare contacts.

v) Ammeter selector switches shall be with off position and with make before break feature and shall have 3 positions to read the three phase currents. Voltmeter selector switches shall also be of 3 positions and off position, suitable to read phase to phase voltages.

13) Control Fuses

All control fuses shall be of HRC link type conforming to IS: 13707. All fuses and links shall be provided with suitable identification labels.

14) Control Wiring

a) All wires carried within the switchgear enclosure shall be LSZH insulated and neatly arranged so as to be readily accessible and to be easily replaceable. Wherever necessary, the wires should be run in cable troughs and the wiring should be routed so that the same remains away from areas where electric flame or flash over may occur. No conduit or cables shall be carried through the bus bar chamber.

b) The voltage transformer wiring shall be done by LSZH insulated, 1100V grade multi stranded flexible copper conductor of size 1.5 sq. mm. and all the current transformer and DC control wiring shall be of the same type of cables as specified above with conductor size of 2.5 sq. mm. The colour coding shall be as per IS: 5578 /11353.

c) 20% of extra spare terminals shall be provided. All terminals shall be suitable for terminating 2 wires from bottom and top side of the terminal block. However, not more than one wire shall be terminated from either side on any terminal.

15) Name Plate and Identification

Suitable anodized aluminium name plate of 3mm thick shall be provided on all the switchboards and individual compartments.

16) Earthing

An Earth bus of requisite section shall be provided. It shall extend throughout and solidly connect all panels in line with proper terminals, at the end to connect to the depot

earthing system. The terminal arrangement at the ends shall be suitable for connection to Earth flat and shall be complete with bimetallic washers, etc.

Maintenance free earthing should be provided as per the provisions mentioned vide Railway Board letter no. 2006/Elect(G)/150/5/Pt dated 11.09.2008.

17) Pre-Delivery Inspection Test

All routine tests & type tests / acceptance tests as per Standards

18) Testing at Site

After installation of the LT Switchgear, all the pre-commissioning tests as per relevant standards, has to be carried out in the presence of the Engineer and jointly signed with the Contractor.

13.8 Signages

a) All signages shall be of back lit LED module. Signages shall be aesthetically designed. Power supply to signages shall be through emergency circuit.

b) The signage shall conform to RDSO specification no. RDSO/PE/SPEC/TL/0086-2009 (Rev.'0')

13.9 SCADA for Auxiliary Power Supply

13.9.1 Scope

The scope of work shall include but not be limited to the following:

1) Design, development, manufacture, verification, delivery, installation, testing, commissioning (including integrated testing and commissioning) and technical support for a complete BMS, including all PLC Equipment, CPU's, Modules, Sub Modules, Power Supplies, Local Control Panels, PC Work Stations, Printers, Local Area Network (LAN), Ethernet Hubs and Switches, Remote Fireman's Control Panel, electrical containment and wiring systems, and other components, to fully integrate the control, monitoring, and supervision of Low Voltage Power & Distribution including Energy Metering, Diesel Generator System and strategic emergency power supply from DG sets, UPS, Solar System, Fire Alarm System, etc.

2) Dedicated work station/MMI terminal at OCC and depot will be provided by the contractor. The depot is under construction at New Durgauti. Two number workstation shall be provided at OCC for entire section MGS-DGO-KWDN-SEBN-CPBH.

13.9.2 Functional Requirements:

1) The SCADA arrangement for the section is to be integrated/Upgraded/modified with the existing SCADA arrangement of DGO-KWDN section and is to be commissioned at OCC Allahabad for the entire section. Presently the SCADA arrangement of DGO-KWDN is at RCC/Mughalsarai and is likely to be commissioned shortly.
2) The contractor should study the existing arrangement and interface requirement with adjoining sections and system contractor of OCC/Allahabad.
3) The metering shall be based on open protocol/DLMS/IEC-62056 & shall be supported with all type of communication system such as PSTN, optical fiber, Wi-max, GPRS/3G, GSM/R, etc.
4) All system components are to be designed and built to be fault tolerant.
5) Switchboards, equipment, and other control components shall be rated for operation in ambient temperatures of 50^{o}C and humidity up to 75% and shall have degree of protection IP- 65.
6) In the design of switchboards, local control panels, Cabinets of PLC, an allowance of 20-25% spare space capacity shall be provided for possible future expansion and all

panels shall be user friendly and aesthetic design, termite and vermin proof. Spare capacity of 30% shall be provided for all cable trays, trunking, raceways and brackets, for future expansion.

7) SCADA updating frequency shall be 15 mins. Requirement is enclosed as **Attachment 13.4**.
8) A mimic panel shall be provided in ASM's room of stations where status of some of the functional units like HT, LT Feed, DG set & UPS status can be displayed.
9) All electronic equipment shall comply with the relevant standards.
10) Interface circuitry (SCADA) shall be provided by the Contractor to extend the mains/standby generator indications and manual controls, the status of the mains power supply, UPS, etc. at each station to the local control and indication (VDU) facility at the station, and also to the Operational Control Centre (OCC).
11) Tests shall be carried out to demonstrate that power supply wiring shall be able to withstand a 2kV AC test voltage between line and Earthed or insulated parts.

13.10 Solar Panel

The specification covers general and technical requirements for design, manufacturing, testing, supply, installation and commissioning of grid-tied solar generating system to be provided at stations and TSS. The grid-tied solar photovoltaic system (SPV) shall be provided as under:

13.10.1 System Description

Solar Photovoltaic (SPV) grid-tied system shall consist of mainly the following:-

(1) Solar panels
(2) Module mounting structure
(3) Junction boxes
(4) Power conditioning unit (PCU)
(5) Import & Export metering
(6) Cable and other accessories

DC distribution board/combiner shall be provided in between solar array and PCU. It shall have DC Dis-connector switch/MCCB of suitable rating for connection and disconnection of array section. Type II surge Arrestor should be incorporated for surge protection. It shall have meters for measuring the array voltage and array current.

AC distribution board shall be provided in between PCU and loads. It shall have an integrated energy meter, voltmeter and ammeter. Class 1=II (as per IEC 623050 100 kA Surge Arrestor should be incorporated for protection against surges.

13.10.2 General Requirements

Array structure of PV yard and all electrical equipment such as PCU, inverters, etc. shall be grounded properly. The contractor shall supply and install adequate number of earthing Pits; at least one each for AC circuit, DC circuit and lightning protection system in compliant of IS: 3043-1987.

The reverse current blocking diodes (connected in series) used shall be rated for 2xVoc STC of the PV string.

13.10.3 Technical Requirements

When the grid voltage and/or frequency goes out of pre-set range, the inverter shall be immediately disconnected from the grid. The inverter shall reconnect after a pre-determined time when the grid is back in the range.

For safety reasons, PV inverter system shall be disconnected from the network following a fault or loss of supply on the power network.

The performance and generation data shall be recorded using a data logger. The monitoring system shall comprise of the following main components.

PCU shall long the inverter performance data and transmit the same to the data logger. It shall also monitor basic parameters like power generated, etc.

Data logger shall gather information and monitor the performance of the inverter. It shall also support measurements from the external sensors. Data logger shall also monitor the solar Insulation and Temp of Arrays.

Data logging system/ software shall enable automatic long-term storage of measured data form PV plant. It shall allow visualization, monitoring, commissioning and service of the installation. The data logger shall integrate with SCADA system. It should also be possible to retrieve the data directly from the data logger. The software for access/ visualization of data from data logger should be provided by the supplier free of cost. Necessary executable files, if any, shall be required to be given free of cost by the contractor on a CD/any other storage device.

13.10.4 Communication Interface

The system should offer RS232/RS485 port and LAN/Wan interface to facilitate remote monitoring of the system.

13.10.5 SPV Module

Individual Solar PV Module should be of minimum capacity 230 WP conforming to IEC: 61215 Ed 2 or latest- Edition II, IEC:61730- I:2007, IEC:61730 – II:2007, manufactured in a plant certificate under ISO 9001:2008. The solar 1W Module should be made from mono/poly crystalline silicon Solar Cell connected in series. Cut cells should not be used.

SPV modules shall contain crystalline high power silicon solar cells. The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.

Photo-electric conversion efficiency of SPV module shall not be less than 14%.

Fill factor of the module shall not be less than 72%.

Each module shall have low iron tempered glass front for strength and superior light transmission. It shall also have tough multi-layered polymer back sheet for environmental protection against moisture and provide high voltage electrical insulation. Transitivity of glass shall not be less than 91%.

Bird spike shall be provided so as to avoid bird sitting on the solar modules at the highest point of the array/module structure.

The output of any supplied module shall not be less than the rated output and shall not exceed the rated power by more than 5Wp. Each module, therefore, has to be tested and rating displayed.

The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of solar module. The terminal block shall he preferably of Noryl rubber with weatherproof design (minimum IP 66) and shall have a provision for opening/ replacing the cables if required.

Insulation Resistance of the module shall not be less than 50M-ohm when measured with a 500V DC megger.

13.10.6 Module mounting structure

The array structure shall be so designed that it shall occupy minimum space without sacrificing the output from SPV panels. The array structure shall be made of hot dipped galvanized MS angles of suitable size. Galvanization thickness shall be of min. 85 micro-metre.

The support structure, design and foundation shall normally be designed to withstand wind speed upto 150 kmph or higher as may be encountered.

The module alignment and tilt angel shall be calculated to provide the maximum annual energy output. The shall be decided based on the location of array installation.

The array structure shall be designed with arrangement of rotation of frame/ tracking control so that PC Cells face towards the sun during the day for 1KW and above rating.

13.10.7 Earthing for PV array, Balance of System (BOS), lightning protection and other components.

(1) The photovoltaic modules, Balance of system (BOS) and other components of power plant require proper grounding for protection against any serious fault as guided by IEC 60364.

(2) The contractor shall supply and install an adequate number and appropriate size of IS:3043-1987 compliant earthing kits; at least one each for AC circuit, DC circuit and lightning protection system.

(3) Lightning protection should be provided as per IEC 62305.

(4) The lightning conductor and structures shall be earthed though flats as per applicable Indian Standards with earth pits. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure. Else, a matrix of lightning conductors is to be created which shall be required to be connected to an earth.

(5) The contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment.

13.10.8 Power Conditioning Unit (PCU)

(1) PCU shall supply the DC energy produced by array to DC bus for inverting to AC voltage using its MPPT (Maximum Power Point/Tracking) control to extract maximum energy from solar array and produce 400V (+15% and -20%) AC, ~~e~~3 phase, 50±5% Hz (47.5 to 52.5 Hz) to synchronize with the local grid.

(2) MRPT controller, inverter and associated control and protection devices, etc. all shall be integrated into the PCU. The inverter must have a minimum of two independent MPPT channels inbuilt.

(3) PCU, string inverter shall provide 3 phase, 400V (with grid tracking of +15%/-20%), 50 Hz (with grid tracking of ±5% i.e. 47.5 to 52.5 Hz) supply on AC side with voltage THD of less than 3% and current THD of less than 5%.

(4) The inverter shall be efficient with IGBT based reliable design. The control system should be of highest reliability preferably based on Digital Signal Processors.

(5) The inverter shall be efficient with IGBT based reliable design. The control system should be of highest reliability preferably based on Digital signal Processors.

(6) The PCU shall be capable of complete automatic operation, including wake-up, synchronization and shut down.

(7) Built-in data logging to monitor plant performance through external PC shall be provided.

(8) The inverter should be tested for power conversion efficiency as per IEC 61683:1999/EN 61683:2000.

(9) The inverter should be CE marked for the EMC directive 2004-108-EC and should comply to EN 61000-6-2.

13.10.9 Protections

(1) Following is an indicative list of protections (the actual scheme shall be finalized at design stage):

(a) Over-voltage both at input and output.
(b) Over-current both at input and output.
(c) Over/under grid frequency.
(d) Over temperature.
(e) Short circuit on AC side.
(f) Reverse polarity protection.
(g) Array ground fault protection.
(h) Protection against lightning induced surges Class II, 10 kA as per IEC 61643-1.
(i) Protection against surge voltage induced at output due to external source.

(2) Night consumption of the PCU shall be less than 0.2% of the KW rating of the inverter for system capacities of 25KWP or more. It shall be less than or equal to 50W for system capacities of less than 25KWP.

(3) DC insulation resistance should be more than 50MΩ.

(4) EMI and EMC Requirements: PCU shall comply the following EMI and EMC requirements:

(a) Emitted interference as per IEC: 61000-6-4.

(b) Interference emitted as per IEC: 61000-6-2.

(5) An integrated earth fault detection device is provided to detect eventual earth fault on DC side and shall send message to the supervisory system.

(6) PCU can be a combination of multiple string (10 to 20 kwp each) inverters depending on capacity of SPV.

13.10.10 Cables and Hardware

(1) The cables used in module/array wiring shall be TUV 2Pfg 1169/08.2007 or VDE EPV 01:2008-02 or UL4703 certified. Cables of appropriate size to be used in the rest of the system shall have the following characteristics: Temp, Range (-) 10°C to (+) 120°C.

(2) Halogen-free, low smoke, low toxicity.

(3) Flame retardant.

(4) Fulfils IEC 60332-1 requirements. Accredited lab test report/Manufacturer's test report shall be attached.

(5) Cabling on DC side of the system shall be as short as possible to minimize the voltage drop in the wiring.

(6) Overload protection may be omitted to PV string and PV array cables when the continuous current-carrying capacity of the cable is equal to or greater than 1.25 times I_{sc}STC at any location. Necessary calculations in this regard shall be submitted during design approval.

(7) Overload protection may be omitted to PV main cable if the continuous current-carrying capacity of the cable is equal to or greater than 1.25 times I_{sc}STC of the PV generator. Necessary calculations in this regard shall be submitted during design approval.

13.10.11 AC Distribution Board (ACDB)

The ACDB must have the following features:

(1) Cables connecting bus bar should be minimum 3 times capacity of Solar Power plant.

(2) The Designated Load should be routed through ACDB and an Energy Meter to register the Load Energy Consumption from Solar and Grid during Week Days and Holiday.

(3) ACDB should have Class I + II (as per IEC:62305; IEC:61643 and IEC: 603064-5-53), 100 kA Surge Suppression inbuilt for surge protection. Surge protection on AC side (Type 1 +n Type 2) shall consist of Prewired metal encapsulated spark gap based solution for fire safe and fire proof operation at site, consisting of base part and plug in protection modules. Total discharge capacity/ Lightning Impulse current (limp) at 10/350 microseconds and normal discharge current (In) at 8/ 20 microseconds shall be minimum 100 KA fir three phase power supply system and 50 KA for single phase power supply system. The discharge capability of L-N connected module shall be 25 KA at 10/350 microseconds and 8/20 microseconds. All the LN & N-E connected arresters shall have built in mechanical health indication. Complete solution shall have voltage protection level (Up) of <=1.5 KV to protect the sensitive electronics inside the Invertors, having follow current extinguishing and limiting capability up to 25 mA rms (at 255V) without tripping of even small rating 32 AOL/DO fuse and approved from international independent test labs like KEMA or VDE or UL as per latest IEC 61643-1 or equivalent EN 61643-11 standard. SPDs on ACDB shall be provided if the same haven't been provided on the PCU.

13.10.12 Installation & Commissioning

(1) The installation shall be done by the contractor for system performance, direction of installation and structural stability. The contractor shall conduct a detailed site assessment. The PV installer shall obtain data specific to the site, rather than relying on general data. While making foundation design, due consideration shall be given to weight of the module assembly, maximum wind speed at the site etc.

(2) The installation shall include the electrical wiring, cabling, terminations, cable trays, string inverters, metering and hooking up the system to the electrical panels of the buildings

(3) The 3 phase output of the Power Conditioning Units, PCUs shall be suitably terminated to an ACDB where individual electronic communicable metering and summation metering of accuracy class 0.5s shall be carried out. The Output of the ACDB shall be suitably connected to the LT grid for feeding power to the building load. The energy supplied by Solar PV system shall be monitored and available in the central display. In case of grid failure, the inverter shall be isolated from the circuit. Suitable provision, protection as per the IEEE 929, UL 1741, IEEE 1547 and IEEE 1543 shall be provided.

(4) Supply and installation and testing of entire system including automatic synchronization and isolation with plant main LT Panel grid and UPS.

(5) The system must be capable of communicating with PCUs on a network logging all parameter like generated power in KW/KVA, voltage, current, frequency etc. inclusive of Energy meter (Electronic/Multifunctional).

(6) Supply and installation and testing of entire system including automatic synchronization and isolation with plant main LT Panel grid and UPS.

(7) Contractor shall design their SPV panel structure according to RCC roof. Design of SPV structure and distribution of load on roof top beam shall be coordinated with the civil structure design, well in advance. Contractor shall provide the staircase or pathways for accessibility of Solar PV panels if not provided.

(8) Data networking cabling as per site requirement from PV solar system to existing plant room.

(9) Danger notice plates at some prominent locations as per IS:2551.

(10) Contractor shall ensure that the installation, performance, testing, commissioning, warranty, etc. are as per latest MNRE guidelines. Selection of SPV modules shall be made on the basis of the output which shall not be less than 99.5%.

13.11 Laying of HT / LT Cable

13.11.1 Laying of Cable

(1) Cable shall be laid underground/ road/ railway or passing through GI pipe erected with the pole including recessing in wall as required and as approved by the Engineer and shall include HDPE/ GI pipe as required, digging of cable trench in ground, making chase in wall sand cushioning, protective covering with second class bricks, back filling of the trench/ making good the chase, making end termination with aluminum, crimping socket/ lugs etc. as per the approved drawings.

(2) In case of the cable to be laid underground in pipes, the pipe shall be of the approved dia., ISI marked, socket and spigot type. Trench for laying the pipes shall be excavated in straight lines. Thereafter the trench shall be backfilled with the excavated Earth / good quality Earth in layers not exceeding 300mm, rammed and watered as necessary.

(3) In case of the cable to be laid underground under running roads/urban areas, it shall be laid with trenchless method and shall include GI pipe of suitable grade of the approved dia. with couplers and as approved by the Engineer. Drilling/ boring shall be in straight lines, as far as possible.

(4) The cable laying work shall be done in accordance with CPWD General Specifications for Electrical Works - Part II (External) 1994 with latest amendments and IS:1255-1983.

(5) Testing of the complete installation shall be as per relevant clause of CPWD General Specifications for Electrical Works- Part II (External) 1994.

(6) Cabling under railway tracks shall be under hume pipes of class NP-2. All cables from sub-station to various locations (Station building, pump room, street light panel, yard lighting, high mast panel) shall be laid through GI pipes (class "B"), ISI mark. Pipe lengths should be joined together with screwed couplers & sealed.

(7) To prevent entry of rodents, dust, water, cables passing through the walls or entering the installation shall be through EDPM based modules made of Ethylene Propylene Diene Terpolymer. Module shall have low smoke index, halogen free cross linked rubber compound.

(8) Minimum depth of top of laid Cable/ pipe at various locations from the ground surface shall not be less than as indicated here under:

Sl. No.	Location	Depth of top of laid cable/ pipe	Remarks
1.	Under-ground	Not less than 750mm for LT cables and 1000mm for HT cable	Cables to be laid in single tier formation
2.	Under road	Not less than 1000mm	
3.	In wall/ floor	To be recessed (for LT cable)	
4.	Other than above	As approved by the Engineer	

(9) Minimum width of cable trench for laying of Cable at various locations shall be as under:

Sl. No.	Location	Width of cable trench	Width of cable trench for one additional cable	Remarks
1.	Under-ground	350mm approx.	350mm + 250mm	Brick on edge should be laid in between the two juxtaposed cables
2.	In wall/ floor	To be recessed as approved by the Engineer	As approved by the Engineer	
3.	Other than above			

(10) Protective covering, sand cushioning of cable & making good the surface at various locations shall be as under:

Sl. No.	Location	Protective Covering	Sand Cushioning	Surface
1.	Under-ground	Brick 9"x4"x2½ " (normal size), Width wise on top and length wise on sides	Base cushion 80 mm under cable &150mm above laid cable	Making good as original
2.	Under Road	Through laid pipe	-	-
3.	In wall/ floor	Plastering	-	Making good as original
4.	Other than above	As approved by the Engineer	As approved by the Engineer	As approved by the Engineer

13.11.2 Cable Route Marker

(1) Proper cable route marker shall be used.

(2) The route marker shall be mounted parallel to, and at a distance of 300mm from the edge of the trench and shall be grouted with cement, sand & aggregate mixture in ratio 1:2:4 at a depth approx. 400mm in ground. The word “Voltage”, “Size of cable”, ‘’DFCCIL’’ and “Depth” should be inscribed on the route marker plate.

13.11.3 MS Chequered Plate for Covering Cable Trenches

5/6 mm thick MS chequered plate shall be used for covering cable trenches in sub-station. It shall be cut to size as required and painted with enamel paint of approved shade after treatment of anti-corrosion.

13.11.4 GI Pipe for Passing Cable

GI pipe shall be of dia as required and shall be ISI marked and shall not be less than of Class ‘B’. It shall include making chase and plastering/distempering/finishing after laying of the pipe in wall or on platform/digging of trench under the railway track / road and back filling of the trench with excavated Earth after laying of pipe and making good the damages. Excavation shall be done complying with Code of safety as per IS: 3764-1992 (latest version).

13.12 Automatic Power Factor Capacitor

13.12.1 Scope

This specification covers the requirements of design, manufacture, supply, test and commissioning of APFC Panel complete with all accessories for efficient and trouble-free operation.

13.12.2 General

(1) 415V capacitor banks are intended for supplying compensating leading VARs, thereby improving the overall power factor of the connected load. Capacitor units shall be mounted inside the APFC panel, in separate cubicles.

(2) APFC panels with detuned filters complete with necessary controls, relays, protection and accessories as per the specific requirements shall be supplied.

13.12.3 Design and Construction Requirements

(1) 415V capacitor banks shall be of self-supporting, self-healing type conforming to IS: 13340 - 1993, 13341- 1992 & 13925 – 1998, floor mounting type APFC panel with degree of protection of enclosure IP54 as per relevant standard. Minimum thickness of sheet steel shall be 2.5mm. Control and protection elements for 415V capacitor banks shall be mounted on capacitor bank panel itself.

(2) Main Earth bus shall be run at the bottom of panel. Each capacitor unit body shall be connected to the Main Earth by means of Cu. Wire. All metallic supports shall be Earthed.

(3) All instruments and power factor correction relay (PFCR) shall be neatly arranged on the front side and shall be flushed mounted.

(4) The Contractor shall design / select the required component conforming to IS standards to make the system complete.

(5) The panel shall be provided with earthing terminals, cable gland plate, space heater and cubicle illumination lamp.

(6) Both manual and automatic control of power factor correction shall be provided.

Auto / manual selector switch for the above shall be provided on capacitor control panel.

(7) The following power supplies shall be made available to the panel by the *Contractor*:

a) 230V, AC, single phase (for panel space heater and panel illumination).

b) The control supply shall be tapped from main incomer supply.

(8) The system shall be provided with automatic power factor control relay. It shall be a microprocessor based static unit with output relays equal to the no. of capacitor steps. Minimum no. of relays shall be six (6) so as to maintain power factor in the range of 0.95 lag.

13.12.4 Capacitor Banks

(1) 415V capacitor banks shall be of super heavy duty low loss, complete in set, mixed dielectric type and shall be sized to appropriate rating to improve the power factor with target of 0.92. Existing power factor can be considered as 0.8. Shall be placed on a suitable location on incoming side as per directive of the Engineer. The capacitor shall be of the type and capacity as approved by the Engineer.

(2) The capacitor shall be designed to carry a maximum current 1.8 times the rated current of capacitor, continuously. The components shall be suitably derated.

(3) The capacitor units shall be hermetically sealed for complete protection against leaks. Capacitors shall be certified under UL 810 recognition programme.

(4) Capacitors shall become part of the LT control panel and shall be located preferably at the top tier /rear side with substantial ventilation louvers for the dissipation of heat, energy due to capacitor losses. The lower/front tiers of the panel shall accommodate switches, MCB's, contactors, and power factor control relay for the automatic switching of the capacitors. The panel shall be cubicle type forming the part of main LT panel.

(5) Capacitors shall be heavy duty metalised polypropylene dielectric media. Unit shall be of low loss and be able to withstand 10% over voltage and also suitable for continuous operation at 135% of rated KVAR. Insulated leads shall comply with UL 62.

(6) Capacitors shall be subject to test program as per UL810 to evaluate protection devices within the capacitor, dielectric strength, life etc. & other routine & type tests as per IS:2834.

13.12.5 Discharge Resistor

The capacitor units shall be provided with discharge resistors and can safely discharge the capacitors to less than 50V within 1 minute upon disconnection.

13.12.6 Detuned Filter

(1) LV Harmonic Filters shall be used with harmonic detune filter, heavy duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

(2) The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

(3) The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

(4) The reactor shall be tested using a separate source voltage test of 0.3kV (coil to

core) for 1 minute as per IEC 60076/3.

(5) The permitted tolerance of inductance shall be +3% of rated inductance value.

(6) Reactor tuning factor shall be as per design requirement and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

13.12.7 Protection

All capacitors shall be suitably protected against over current and short circuit.

13.12.8 Tests

(1) All the acceptance tests as per relevant IS Standards shall be carried out in the presence of the Engineer and jointly signed with the Contractor.

(2) The Contractor shall furnish all the reports of all the type tests carried out. Tests shall be as per specification and relevant standard for all components / equipment / systems. These reports should be for the tests conducted on identical / similar components / equipment / systems to those offered / proposed to be supplied under this contract.

13.13 Diesel Generator Set (DG Set)

13.13.1 Scope

(1) The Contractor shall supply, install, connect, test and commission a complete system of diesel generator set 50 KVA in accordance with the Drawings and Specifications approved by the Engineer.

(2) The DG set shall be working as single unit for catering to mixed load comprising electrical power and for charging battery, Average power factor of load being 0.8 lagging. The DG set should be suitable for operation as per site conditions.

13.13.2 Material Description

The Contactor shall Design, manufacture, supply, including transportation, storage, loading / unloading, insurance and safe custody till handing over, installation, testing and commissioning of the sound attenuated Diesel Generator set.

(1) DG Set with Acoustic Enclosure for Emergency Power Supply

a) DG set shall be of the required capacity / rating and shall be complete with diesel engine, copper wound alternator mounted on a common base frame, battery set, anti-vibration pads, fuel tank, and other connected accessories / equipment / protective devices etc. along with AMF control panel comprising of MCCBs of approved rating, copper bus bars of approved capacity, 4 pole heavy duty connectors of approved rating, Multifunction Panel Meter display parameters indicating Current and Voltage on Phases and Lines, Power Factor, Frequency, KWH, MD etc. LED indication lights including connection with cables as required.

b) The DG Set shall be able to start automatically in all climatic conditions and shall take full load within 10 seconds of failure of the normal supply through an automatic change over switch. On resumption of the supply, the change over to the normal supply shall initiate automatic shutdown. DG set shall also include acoustic enclosure, LT XLPE insulated unarmoured single core aluminum conductor cable of approved size and all other accessories including foundation & supply of High Speed Diesel oil lube oil etc. as required for testing & commissioning at Site to the satisfaction of Engineer.

(2) Other Requirements

Other requirements shall be as under and as per drawing approved by the *Engineer.*

a) Site Conditions

i. Height above mean sea level: As per site of installation (Site Levels are as indicated in Employer's Requirement Drawings)

ii. Maximum ambient temperature : 50 degree C

iii. Relative humidity : 75%

b) Rated Power Output

i. The Diesel Generating Set shall be capable for delivering continuously (on 24 hours basis) power output at 1500 rpm at site conditions and the engine shall confirm to IS 10000 / BS: 5514 (latest version)

ii. The diesel engine shall be capable for working on 10% over load for one hour in any 12 hours running.

c) Oil Engine

i. The diesel engine shall be cold starting, vertical direct injection, 4 stroke cycle, water radiator cooled, turbo charged, electric battery start, directly coupled to the alternator mounted on a combination base plate frame through a flexible coupling. Most compact, extremely robust and rugged design. Minimum 500hrs oil change interval, meeting emission norms and self-starting. A suitable extension pipe shall be used with exhaust air chest so that the silencer can be mounted.

ii. Fuel Tank

- A fuel tank for storing the fuel oil with a capacity corresponding to 12 hrs. consumption of the D.G. set.
- The fuel tank shall be protected by an appropriately sized bond wall, capable of containment of its full capacity.
- The engine shall be required to operate on Diesel Fuel Oil grade 'A' to IS: 1460.

iii. Governor : The engine shall be supplied with inbuilt governor to maintain the engine speed at varying loads. The governor shall conform to Class A-1 or G3 as per BS / IS (relevant)

iv. The engine shall be complete with standard accessories and protective devices.

v. Silencer Unit : Specially designed heavy duty residential type low noise silencer meeting the sound pollution norms of CPCB. Exhaust pipe shall be wrapped with asbestos/ mineral wool and aluminum cladding.

vi. Emission Related Parameters : Emission Related Parameters should be in accordance with Central Pollution Control Board norms as applicable at the time of supply.

(3) Alternator

The alternator shall be self-exciting brush less technology, copper wound, self-regulating with screen protected enclosure suitable for feeding 415V, 3 phase, 4 wires, 50 Hz AC supply with neutral point brought out. The alternator shall confirm to BS: 5000 / IS: 4722 and winding shall conform to class 'H'/ 'F' insulation. Alternator shall be provided AVR and of Voltage regulation within (±1%) of the rated

voltage from no load to full load and permissible over load of 10% for one hour in 12 hours operation.

(4) Automatic Main Failure Panel (AMF Panel)

The AMF Panel shall be capable of starting the Diesel Generating set in the event of main power supply failure or low voltage below the specified value and changeover to load from main supply to DG set.

The AMF Panel shall be connected and provided with suitable interlocking arrangements to avoid incident of paralleling of normal supply to the Generator Set.

(5) Arrangement

The engine shall be directly coupled to the alternator through flexible coupling and both the units including the radiator shall be mounted on a rigid fabricated bed plate. Base plate shall have threaded holes for holding of down bolts for mounting engine and alternator.

All the equipment shall conform to latest version of IS Specification & International standards given in Annexure-IV & V.

(6) Tests

The generating sets shall be tested at the OEM works in the presence of nominated representative for:

a) Guaranteed fuel consumption
b) Over Load Capacity
c) Proper operating protective devices provided for safety of the generating set and AMF Panel.

(7) Acoustic Enclosure

Requirement shall be as per technical details furnished here under:-

a) The acoustic enclosure shall be made of 14 SWG CRCA sheet
b) The enclosure shall be powder coated (inside and outside) with a special pure polyester based powder. All nut and bolts/ external hardware shall be made from stainless steel.
c) The doors shall be gasketed with high quality EPDN gaskets to prevent leakage of sound
d) Noise level should not be more than 75 dB at 1 meter distance.
e) Temperature of enclosure should not exceed beyond 7 ^{0}C of ambient temperature
f) Weatherproof, Sound proofing of the enclosure shall meet the latest CPCB norms and shall be done with high quality rock wool/ mineral wool conforming to IS: 8183. The rock wool shall be further covered with fiber glass tissue and perforated sheet
g) A special residential silencer shall be provided within the enclosure to reduce exhaust noise
h) There shall be a provision of emergency shutdown from outside the enclosure
i) Satisfactory operation at 50ºC ambient.
j) Insulation material shall conform to UL 94HF1 class for flammability.
k) Use of zinc plating with green passivated hardware to withstand salt spray test as per ASTM B-117.

13.13.3 The DG Set shall conform to environmental and noise pollution norms of Central Pollution Control Board.

13.13.4 Testing and Commissioning

(1) After installation, the DG set shall be run for a minimum period of 30 minutes continuously on no load. On satisfactory completion of the no-load run the DG set shall be run for a period of one day for 6 hours at 100% full load. All consumables including fuel lube oil and load banks required for commissioning of the DG set shall be supplied by the Contractor. Test readings together with an hourly log of the running test shall be furnished to the Engineer.

(2) Any abnormal condition occurring during trial run of the DG set shall also be recorded and brought to the notice of Engineer. Test results shall be recorded at 30 minutes intervals. Tests proving the satisfactory performance of all operating gear, safety functions and controls shall be carried out.

13.14 Earthing, Bonding and Lightning Protection System

13.14.1 Scope

(1) The Contractor shall supply, install, connect, test and commission a complete system of safety grounding and lightning protection in accordance with the Drawings and specifications herein.

(2) All the non-current carrying metal parts of electrical installation shall be Earthed properly. All metal conduits, cable trays, trunking, cable sheaths, switchgear, distribution fuse boards, light fittings, fans and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. Earthing shall be in conformity with Indian Electricity Rules.

(3) Earthing System shall be carried out on the sub-station & Equipments including provision of main Earth terminal in equipment rooms.

(4) The Earthing System shall also conform to the following:

a) It shall comply with India Electricity Safety Rule 1956, National Building Code, and railway Guidelines.

b) IEEE 80: 2000 Guide for safety in AC substation.

c) Earthing practices as laid down in CPWD specification for Electrical Work Part-1 Internal 2005 shall be referred.

d) The material used for earthing shall preferably be UL listed.

e) Maintenance free earthing should be provided as per the provision mentioned vide Railway Board letter No. 2006/Elect.(G)/150/5/Pt. dt. 11.09.2008. The guidelines on provision of conventional and maintenance free earths for earthing for different types of installations are laid down in the table given below:

SN	Location/Type of asset	Application/Type of earth		
		Conventional earths (GI with Charcoal/salt)	**Maintenance free earths with ground enhancing material**	**Cluster earths with 75% conventional & 25% maintenance free earths with ground enhancing material**
1	Residential buildings/blocks with connected	-	-	-
	(a)<15KW connected, load	√	-	-
	(b)> 15KW Connected, load	-	-	√
2	Major service building	-	-	√
3	Small service building	√	-	-
4	**i.** Deep well submersible pumping installations minor	-	√	-
	ii. Pumping installations major	-	-	√
5	Sub-Station (PS)	-	-	√
6	High masts	-	√	-
7	Individual high end customer interface like PRS, UTS FOIS, COIS, AVMs Cyber Cafes etc.	-	√	-
8	SCADA & RTUs	-	√	-
9	Major Railway station building (A or A-1 & other tourism, commercial importance)	-	-	√
10	Minor stations building (B,C,D,E)	-	√	
11	Switchgear installed by Railways at incoming supply points from distribution companies (DISOMs)	-	-	√
12	TSS, SP/SSPs.	-	-	√

13.14.2 Material Description

(1) The material for earthing and lightning protection system shall consist of ground rods with pits, ground conductors, test boxes, lightning down conductors, lightning conductors, air terminals and accessories interconnected for the complete system.

(2) The earthing system is primarily of G.I. and the earthing configuration is as per IS: 3043 – 1987. The *Contractor* shall ensure that the intents of the earthing configuration are met with, by providing a single-phase-ground Fault Current, sufficient enough to trip all the circuit breakers and fuses in the system.

13.14.3 Earthing& Bonding shall accomplish the following requirements:

(1) Protect Personnel and equipment from electrical hazard.

(2) Achieve a reduction in potential to the system neutrals

(3) Keep the Touch Potential within safe limits and prevent possibilities of voltage rise to ensure faults are cleared by circuit protection.

13.14.4 Lightning Protection System

a) Protection of building against lightning shall be done in accordance with IS: 2309-2005 and include the provision of a parallel path lightning system complete with air terminal conductors, ground terminals, interconnecting conductors & other fittings required for the complete system.

b) The procedure for lightning protection system shall be as laid out at General Specifications for Electrical Works Part-1(Internal)-2005 issued by CPWD, Chapter- 9.

c) Lightning detection and protection system should be as per the requirements of the National Building Code of India 2005.

13.14.5 Installation

All equipment shall be installed at the locations as indicated on the drawings and conforming to the standard as specified.

13.14.6 Testing and Commissioning

Following Earth resistance values shall be measured with an approved Earth megger and recorded:

a) Each earthing station

b) Earthing system as a whole

c) Earth continuity

13.15 Cable Sealing System

13.15.1 Scope

(1) After erection of materials and equipment through wall and opening has been completed, it is the responsibility of the *Contractor* to fill up voids and openings with fire resistant materials to protect fire or smoke from spreading out from one room to other room or one floor to another floor through these voids and openings.

(2) Foolproof sealing system is a pre-requisite for protection against Fire, Water, Energy/Power Loss, Humid Temperature Variations, Pull Tension and Rodents, wherever cables are entering in to the Electrical Sub-station, Control Room, SCADA Room, Electrical Equipments, Cabinets, Power and UPS Room,

Transformers and Power equipment.

13.15.2 Material Description

(1) Specifications: Composition: Low Smoke Index, Halogen Free Rubber compound based on Ethylene Propylene Diene Terpolymer (EPDM). The material (EPDM rubber) of module with center plug/wrap/core shall be fire resistant as per UL 1479 of BS 476/20 and ensure protection against Dust, Water and penetrating solid objects as per IP54, IP66 and IP67 (IEC 60529).

(2) The fire resistant rating of the sealing material shall be more than 2 hours.

13.15.3 Installation

The fire barrier materials shall be installed where:

a) Voids, sleeves, and openings appear on wall, floor, beam and shaft, provided for raceway installation, which must be sealed after the erection work, shall be completed.

b) Voids, sleeves, and openings provided for future installation.

c) Voids exist between electrical conduits and sleeves.

d) Voids exist between electrical cabling and raceway on fire wall and floor.

e) Voids exist between raceway and sleeves on fire wall and floor.

f) The method of fire barrier installation shall be in accordance with the manufacturer's instruction and listings.

13.15.4 Testing and Commissioning

The testing method shall be as provided by the manufacturer.

13.16 Fire Detection and Alarm System

13.16.1 General

(1) A study shall be conducted by the contractor to identify the Fire hazards, analysis and mitigation measures. Fire detection scheme shall be developed and submitted for the approval of Engineer.

(2) Fire detection and alarm system for the stations buildings & other buildings shall be as detailed below:

(a) Fire detections and alarm System shall be provided in equipment rooms of Station Buildings, ASM room, Control Room Buildings of RSS/TSS, SSP, SP and Signalling & Telecommunication equipment room in block section. The Response indicator shall be placed outside on top of the entry doors. A 2-8 loop Fire alarm & control panel as required shall be housed in ASM room. Fire detectors used shall be intelligent analog addressable type and shall conform to NFPA-72 standards.

(b) Fire Alarm & Control Panel (FACP) along with alarm or hooter shall only be provided in ASM room/control room buildings/ any other identified location as confirmed by The Engineer.

(c) The Fire Detection & Alarm System shall be designed, installed, verified, tested, and commissioned to the requirements of respective NBC 2005 Part-IV standards/NFPA-72 standards and NFPA 130 at stations.

(d) All these works shall also be in conformity to the statutory requirement of respective area Fire Service practices for which necessary clearance shall be obtained.

13.16.2 FUNCTIONAL REQUIREMENT

(1) The main purpose of the installation of a fire detection and alarm system at stations and other service buildings is to detect a rising fire in its early stage, to take counter measures immediately, and thus prevent the spread of fire and protect life and property from severe damage, and maintaining the operation of the building and its services provided with necessary communication port and software as needed.

(2) The Fire Alarm System shall be ready fit to tie-up with the Auxiliary/ Traction SCADA, Local Control and Mimic Panel into an Integrated System.

(3) The Fire Alarm System shall conform the National Building Code of India.

13.16.3 Fire Alarm & Control Panel (FACP) Component

(a) The Fire Alarm & Control Panel shall function as fully stand – alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software and memory and should be listed under UL. The FACP shall be capable of accepting up to 2-8 fire loops as required.

(b) FACP shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACP shall provide tamper protection and command able outputs, which can operate relays or logic level devices. Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACP shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. The following (LED) indicators or RED LCD as approved by the Engineer and control switches shall be provided on the panel:

(i) Indicators:

- System ON
- System Fault/Failed
- Battery ON
- Alarm Condition (supported by Buzzer/ hooter)
- Trouble Condition.

(ii) Control switches as approved by the engineer:

- Reset
- Alarm acknowledge
- Alarm silence
- Trouble silence
- General alarm (evacuation)
- Lamp test

13.16.4 POWER SUPPLY

13.16.4.1 Power Supply Unit

The power supply unit of FACP shall have the following characters:

(1) The main power supply shall be 230 VAC, 50 HZ and shall in turn provide all necessary power to FACP.

(2) FACP shall be provided with a battery charger for 24 hrs. for standby power

using dual-rate charging technique for Trickle, Boost and float Battery charging. Contractor shall provide Maintenance free lead-acid battery as approved by the Engineer.

13.16.4.2 Initiating Devices

(1) Heat Detectors

(a) Automatic heat detectors shall be of the analog addressable type using the latest algorithm principles for accurate indication of normal condition, pre-alarm and alarm indications.

(b) The heat detectors shall be of the combination, fixed and rate-of-rise sensors. The fixed temperature setting shall be 72°C and rate-of-rise temperature setting shall be 9°C (15°F) per minute.

(c) The detectors shall comply with the applicable requirements of UL 521 and shall be resettable type.

(2) Smoke detectors

(a) Automatic smoke detectors shall be of the intelligent analog addressable type, using the latest algorithm principles for accurate indication of normal condition, pre-alarm and alarm indications, complete with plug-in base and auxiliary contacts.

(b) The smoke detectors shall be of the photo-electric type which operates on the light scattering principle utilizing a solid-state infrared LED and high speed, light sensing photo diode within its sensing chamber to detect visible products of combustion.

(c) The detectors shall comply with the applicable requirements of UL 268.

(3) Manual Actuated Alarm-Initiating Devices (Manual Stations)

(a) The manual station shall consist of a push button switch housed in a dust tight sheet steel enclosure of minimum 1.5 mm thick sheet to manually initiate audio-visual alarms. The front shall be sealed with a breakable glass cover fixed in such a way that the actuating push button is kept depressed as long as the glass is intact and released automatically when the glass is broken.

(b) The Manual stations shall comply with the applicable requirements of UL 38.

(4) Combined Optical Smoke & Heat Detector

The detector shall operate on light scattering principle, containing an emitter and photo sensor. The scattered light reaching the photo sensor shall be proportional to the smoke density inside the detection chamber. It shall combine both optical and heat detector technology to detect clear burning fire products, which hitherto could only be easily detected by ion-chamber detectors. The detectors shall not operate on a rate of rise of temperature alone. It shall meet the UL standard. The detector shall be fully operable between -200C and +700C and up to 95%relative humidity non-condensing. The Combined Optical smoke & Heat detectors shall be installed in the most areas.

(5) Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on loop. In stations, the alarm (hooter) may be placed in the station master room.

(6) Hooter/ buzzer:

The FACP on detection of the Fire hazard as noticed by the detector shall activate the requisite enunciator/ hooter or Buzzer.

(7) Response Indicator

Response Indicator shall be provided outside the unmanned/ locked areas / room. The Response Indicator shall glow clearly in case the detector to which it is connected gives an alarm signal. The word "FIRE" shall be clearly written on the visible face of the box. There shall be two numbers of red LEDs to compensate for fusing of either LED.

The Response Indicator shall also have the words “ROOM” or “ABOVE FALSE CEILING” screen printed on it, as the case may be RI should be separate for each level i.e. detectors in false ceiling, flooring should not be provided with common RI.

(8) Conduit and Wiring

Main control wiring loop shall be twisted with shield Fire Survival (FS) Cable and wiring shall not be less than 1.5 mm2 FS Cable for initiating devices and 2.5 mm2 FS Cable for alarm indicating devices and run in conduits. The number of wires and size of conduits shall be in accordance with the manufacturer's recommendation or as shown on the drawings. Supply and return lines for initiating devices must be in separate conduits or raceways.

13.16.5 TESTING AND COMMISSIONING

(1) These shall prove that:

(a) All equipment cabling and distribution is electrically and mechanically safe.

(b) All cables, cores and terminations are properly made off, secure, properly supported and correctly identified and coloured.

(c) All phases, polarities, neutral and common connections are correctly switched as required, that power is correctly available at all points and that voltage and frequency at all equipment is correct and in accordance with the requirements for correct working.

(d) All supplies are properly provided with fuse, or otherwise protected to give satisfactory discrimination and safe disconnection under fault conditions.

(e) Batteries are properly ventilated, installed, connected and fitted, and that battery chargers are working correctly.

(f) Insulation resistance of all cabling and equipment is not less than that required by the requirements of the appropriate Statutory Authorities.

(g) All instruments and meters are energized with the correct polarity and working properly.

(h) All fault indications and alarms are working correctly.

(i) All essential equipment fed from battery systems continues to function correctly and without disturbance during all supply failures, restoration and standby sequences.

13.16.6 Additional Tests

(1) Additional tests shall be performed to verify that the complete electrical

installation shall meet the requirements of this Specification. The list provided below is indicative of the minimum tests required.

(a) Cables

(i) Continuity Test

(ii) Insulation Resistance Test

(iii) Earth Test

(iv) Polarity Test

(2) The Fire Detection & Alarm Systems shall be tested in accordance with NFPA 70 & 72. Each component and assembly shall be type tested and functionally tested before installation, and the entire system functionally tested for correct operation including all interfaces with the other systems.

(3) Minimum required tests are as follows:

(a) Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each shall be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.

(b) Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.

(c) Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each area, including making all possible alarm and monitoring initiations and using all communications options.

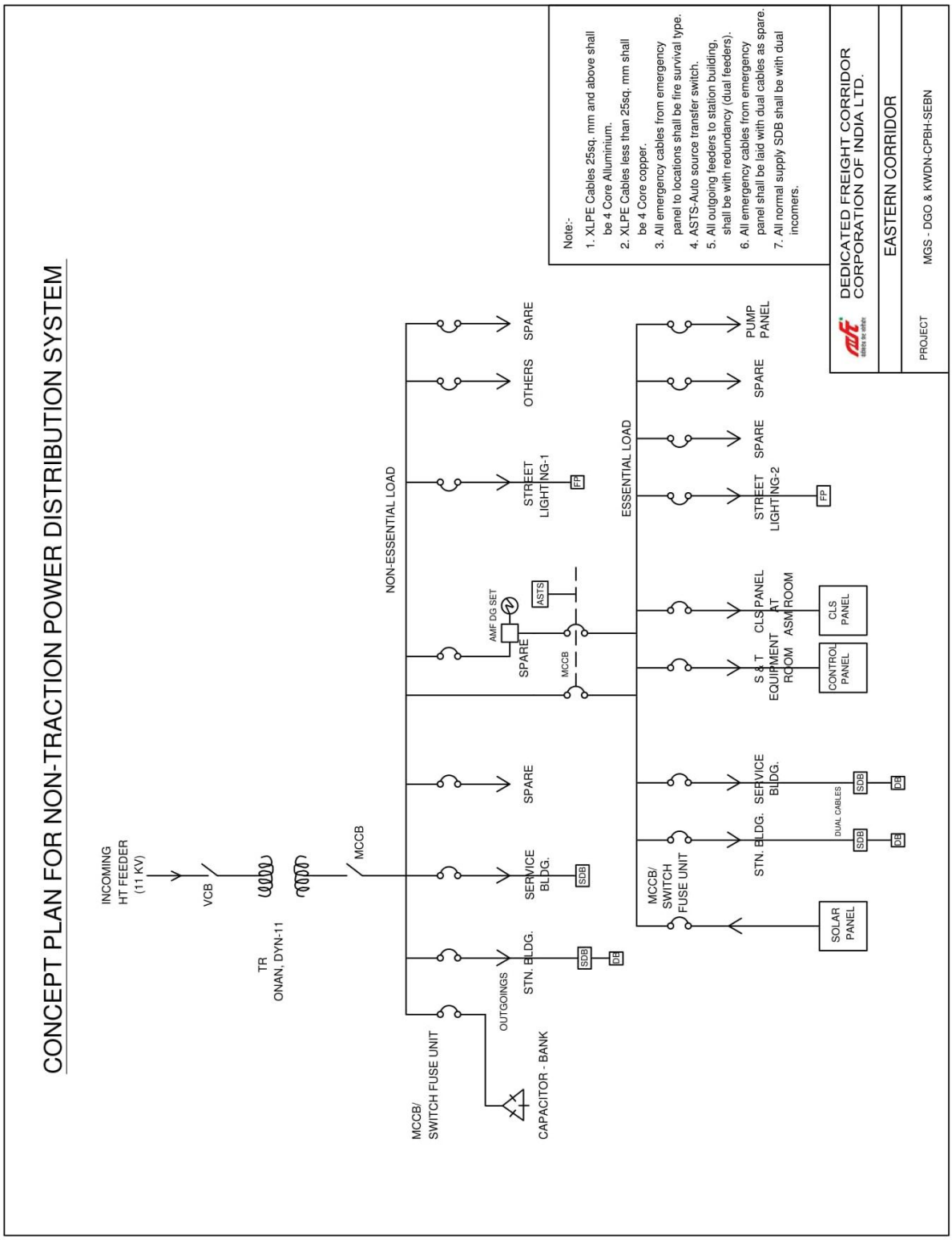
(d) Complete testing of automatic and manual fire alarm system.

13.16.7 Other Requirements

GI fire buckets filled with dry sand and held on free standing stand manufactured with MS angle frame 50x50x6 mm with base and hanging arrangements for buckets on specified locations.

- - END OF CHAPTER - -

ATTACHMENT 13.1



Attachment 13.2

Power Supply Arrangement

Location	AT UP/DN	Local Utility	ASTS	DG Set	Solar system
Level Crossing/Auto signaling Huts/Telecom Huts	✓	--	✓	--	--
Station (New Sonnagar and New GanjKhwaja)	✓	✓	✓	✓	5.0 KW
Cabin (New ERC Mughalsarai, New SonnagarLink and New Chirailapathu)	✓	--	✓	--	--
Other S&T Installation	✓	--	✓	--	--

Note: Further, Buildings in the project and E&M facilities at a glance are given in Appendix 3 (Design and construction interfaces) of Part 2: General Specification.

The air-conditioning/ventilation requirements for S&T installation of stations and cabins shall be as per OEM's recommendations.

ASTS= Auto Source Transfer switch

Attachment 13.3

MATRIX OF REQUIRED FACILITIES AT VARIOUS LOCATIONS

SN	Parameters	Station Building (New Sonnagar and New Ganjkhwaja)	Cabin (New ERC Mughalsarai, New Sonnagar link & New Chirailapathu)	Level Crossing	RSS/TSS, SP, SSP
1.	Solar Panel	✓	NA	NA	At TSS only
	Capacity	5.0 kW	NA	NA	2.0 KW
2.	Solar Geyser	✓	NA	NA	NA
3.	DG Set Supply	✓	NA	NA	NA
4.	Fire Alarm Control panel	✓	NA	NA	√
5.	Desert Coolers (DC)/ Air Conditioners (AC)	DC/AC	AC	NA	NA
6.	Water Coolers	✓	NA	NA	NA
7.	Traction Supply (AT Supply)	✓	√	✓	√

Note: The air-conditioning/ventilation requirements for S&T installation of stations and cabins shall be as per OEM's recommendations.

Attachment 13.4

INPUT/CONTROL PARAMETERS FOR SCADA (NON-TRACTION POWER SUPPLY)

SN	Functional Unit	Input Parameters	Control Parameters	Sampling Rate
1	DG Set	Status (ON/OFF)	Remote operation/ shut down of DG set	Every 15 minute
	DG Breaker	DG Breaker Operation		Every 15 minute
2	Main HT Panel	Supply Availability, Electrical Parameters, Voltage, Current, Power Factor etc.	Breaker Control, Energy monitoring	Every 15 minute
3	Main Distribution Panel	Supply Availability including Solar, Electrical Parameters, Voltage, Current, Power Factor etc.	Energy Monitoring on outgoing feeders	Every 15 minute
			Breaker Control	Instantaneous
4	SDB's (At Station/Service building,	Supply Availability	NIL	Every 15 minute
5	Fire Alarm Control panel	Status	NIL	Every 15 minute
6	AT Supply Availability (Within Station Limits)	Status	NIL	Every 15 minute

14 Electrification of RSS, TSS & Switching Posts

14.1 Scope

14.1.1 This Chapter deals with the provisions of power supply to the equipments, internal electrification of RSS, Traction Sub-Station and Switching Station Buildings and their yards.

14.2 Wiring

14.2.1 The contractor shall follow recessed conduit wiring system for internal wiring of the RSS, TSS & Switching Station buildings. Stove enameled, jet black, steel seamless conduit pipes of standard diameter, conforming to IS: 9537 (Part-2) with latest amendments, shall be used. No conduit pipes having a diameter of less than 19 mm shall be used. All conduit accessories like bends, inspection boxes, elbows, draw boxes, junction boxes shall be of threaded type and shall conform to IS: 3837 with latest amendments. The conduits shall be recessed in the wall/ceiling.

14.2.2 The conduit of each circuit or section shall be complete before conductors are drawn in the entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to Earth by means of a special approved type of earthing clamp efficiently fastened to conduit pipe. A G.I. wire of 6/8 SWG and conforming to IS: 4826 shall be provided along with laying of recessed conduit to facilitate drawing of wires in the conduit.

14.2.3 The wiring shall include circuit wiring and point wiring. The circuit wiring shall include wiring from distribution board up to first switch board along the run of wiring. The point wiring shall include complete wiring of a switch circuit from tapping point on the distribution circuit to the following via the switch.

(i) Connector in case of exhaust fan point.
(ii) Ceiling rose.
(iii) Socket outlet.

14.2.4 Lamp holder looping system shall be used for the wiring. Phase or live conductors shall be looped at switch box and neutral conductor can be looped from the light, fan or socket outlet. All switches shall be placed in the live conductor of the circuit. Power / heating wiring shall be kept separate and distinct from lighting and fan wiring. Light and fan circuit shall not have more than ten points of light, fan & 5 Amp socket outlets or a load of 800 watts whichever is less. A power circuit shall be designed for a maximum of two outlets of a load of 1000 watts each.

14.2.5 The contractor shall prepare a wiring diagram, indicating clearly in plan, main & distribution board, position of all points with their classification and controls and get it approved from the Engineer.

14.2.6 Items to be complied, while designing the wiring system are detailed below:

(i) Type of wiring. Conductor Multi-stranded copper conductor 1100 V grooves FRLS only.

(ii) IS: 732-1989 Code of Practice for Electrical Wiring installations shall be followed.

(iii) Only looping system of wiring shall be followed.

(iv) Procedure of MCB box near entry for switching off supply.

(v) Joints in the wiring shall not be permitted.

(vi) Conduit fill shall not be more than 45% of the capacity of conduit as per IS : 9537

(vii) Maximum wire in the conduit to be laid as per IS: 732:1989 guide lines.

(viii) Fuses on single pole switches shall not be connected in series with the neutral connection of the main power supply.

(ix) Hardware and servers shall be cadmium plated with counter shrunk heads.

14.3 Conduit

14.3.1 The Contractor shall supply and install the conduits in RSS/TSS and Switching Station buildings for internal and external electrification of buildings and yards.

14.3.2 The conduit shall be designed and manufactured in accordance to the Indian Standards or International Standards and accepted by the Employer and shall be installed to comply with relevant provision in IS Specifications, Indian Electricity Rules and IE wiring regulations.

14.3.3 GI Conduits and Accessories

a. The steel conduits shall be made of hot-dip galvanized, produced in electrical resistance welding process with the weld bead on both inside and outside removed in accordance with Indian standard IS: 9537 part 3 or equivalent.

b. Flexible conduit and fittings for life safety equipment shall be galvanized, water-tight pattern, flame retardant, Low smoke and fume, over-sheathed and separate Earth wire enclosed within the conduit (if applicable).

c. The standard manufactured elbows shall be used for all sizes of conduits diameter larger than 1 inch (25mm), and the field bends to be handled with great care not to damage the conduits, shall be permitted to be used for conduit of 1 inch and smaller.

14.3.4 Boxes and Accessories

a. All boxes provided in the conduit work shall be made of metal. A box provided for cable connections and concealed in ceiling shall be a standard galvanized steel square or circular box or a metal box, made of steel sheet with not less than 1.6 mm thickness, with one primer anti-rust coated and two coating finishes.

b. All wall/ceiling boxes on exposed work shall be of die cast aluminium or cadmium-plated cast-iron.

c. All boxes and conduit accessories shall be fully weather-proof when used in outdoor locations and other locations as agreed during construction.

d. Conduit outlet boxes, for socket outlets, lighting switches, etc., shall be of hot-dip galvanized steel complete with adjustable lug, ample knockouts, and brass Earth terminals fitted in the base.

14.4 Main Switchgear and Switch Board: Main Board

14.4.1 Main board consisting of main switch and distribution board shall be situated as near as practicable to the termination of service line and shall be easily accessible without use of external aid. Switch boards of adequate sizes as

approved by the Engineer shall be made of mild steel and recessed in the wall. Front of the boards shall be fitted with 3 mm thick phenolic-laminated sheet similar to Hylme one. All the metal switchgears and switch boards shall be painted, prior to erection with base point followed by two coats of approved enamel point, as required on all sides accessible.

14.4.2 Main switch shall be 230 Volt, MCB of optimum capacity. It shall have cable entry holes, cover handle interlocking, sealing arrangements and weather proof enclosures.

14.4.3 Distribution board shall be 230V, 16Amp, metal clad boards conforming to IS: 2675 with latest amendments with hinged type metallic cover, cable entry holes and weather proof enclosures. It shall have reusable type fuse units.

14.4.4 Switches shall be 230V, 5/15 Amp, one way flush type, piano type switches, conformation to IS: 3854 (Latest version) with latest amendments and shall be ISI marked.

14.4.5 Three pin socket outlets shall be 230Volt, 5/15 Amp, flush type, comforting to IS:1293 (Latest version) with latest amendments and shall be ISI marked.

14.4.6 Ceiling roses shall be 230V, 5 Amp, 2 pole Bakelite ceiling roses, conforming to IS: 371 (Latest version) and shall be ISI marked.

14.5 Earthing

14.5.1 Earthing systems including Earth electrode in accordance with IS: 3043 (Latest version) shall be provided. Loop earthing with G.I. wire of not less than 8 SWG shall be provided for all mountings of the main board and other metal clad switches and distribution boards.

14.5.2 Maintenance free earthing should be provided as per the provisions mentioned vide Railway Board letter no. 2006/Elect(G)/150/5/Pt dated 11.09.2008, (as mentioned in clause 13.14.1(4)e)).

14.6 Lighting System

14.6.1 The Contractor shall design, supply, install, test and commission a high efficiency lighting system for all areas and buildings of the RSS/TSS and Switching Stations. Light fittings for all areas shall be complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, lighting panels, lighting poles/ high mast towers complete with distribution boxes. The light fittings and all associated accessories shall be subject to the acceptance by the Engineer.

14.6.2 Lighting levels shall be uniformly distributed throughout the area, and shall be designed such that glare, dark recesses and areas of poor lighting levels are avoided.

14.6.3 Scale of fittings, Switches & Sockets shall be as under:

- There shall be one MCB Controlling the Power Supply to main distribution board provided for control & monitoring room, battery room, store room and staff room.
- Power Supply of each room viz. control and monitoring room, battery room, store room and staff room shall be controlled by individual MCBs of optimum capacity.
- Control and monitoring room shall have 4 sockets of 5/15 Amp., switches for lighting and fan. Conduits shall be laid underground to facilitate the wiring for telephone, mobile charger etc., up to the table of the supervisor.

- Battery room shall have two power supply points for boost charging of batteries, in addendum to lighting and exhaust fan points.
- Store room shall have ceiling fan & lighting.
- Staff room shall have ceiling fan, lighting, mobile charging point and Desert Cooler point.
- Switching station building shall have the provision of mobile charging, battery charging, ceiling fan and lighting points.
- Two power supply of optimum capacity shall be provided in yard for centrifuging the main transformers and Autotransformers at a optimum location to be approved by the Employer.
- IS: 3646 (Pt. II) – 1996 "Schedule for Values of illumination and above index" is to be followed for scale of illumination. Recommended values of different areas of RSS, TSS & Switching Stations and their yard are tabulated below:

S. No.	Particulars	Average Illumination level (in Lux.)	Index Glare
1.	Control rooms,	200 to 300	19
2.	vertical control panels rear of control panels	150	19
3.	Battery room	100	-
4.	Outdoor switch yard	20	-
5.	Store room	100	-

14.6.4 The Contractor shall meet the below mentioned requirement while designing the system.

- No incandescent lamp shall be used.
- All inside luminaries shall be of LED type of reputed brand. Street/Yard Light as well as high mast tower lights shall also be of LED type.
- Requirement of motion sensors and use of timers or photo electric switches for street lighting.

14.6.5 A sample of system illumination both indoor & yard outdoor as proposed to be adopted by the contractor for each type or installation viz. RSS, TSS, SP and SSP shall be prepared complete with detailed calculation for arriving at the specified Lux level and submitted for approval, shall be approved by the Engineer for each type of building & yard before their use in the contract. The Contractor shall submit detailed calculation for reaching specified Lux level. High mast system for illumination of RSS/TSS should be preferred.

14.7 Luminaries

14.7.1 The luminaries comprise of the lighting fixtures, LED lamps, Drivers street lighting fixtures etc.

14.7.2 Lighting Fixtures:

- The fixtures shall be wired to a single point with approved fixture wire for proper connection.

- All lighting fixtures, when installed shall be set true and free of light leaks, warps, dents, and other irregularities. The finish of exposed metal parts of lighting fixtures and finish trims of all recessed lighting fixtures shall be as directed by the Employer.
- Each lighting fixture shall have a manufacturer's label affixed to it in a concealed location and shall comply with the requirements of all authorities having jurisdiction.
- After the fixtures are completely installed, the wiring system, wiring and fixtures must be tested against grounds and short circuit.

14.7.3 Occupancy of wiring cable of conduit shall not exceed 45% of the capacity of conduit as per IS: 9537.

14.7.4 Provision of astro timers for auto switching of street/yard lights.

14.7.5 Pre-wired Street Light Luminaire

Prewired luminaire shall be of approved make and LED type, energy efficient and complete with drivers, LEDs (of wattage as required and as approved) etc., 2x1.5 + 1x1.5 sq mm, FR PVC insulated multi-stranded single core copper conductor cable, GI pipe bracket (of approved length) and GI flat clamps with nuts and bolts etc. as required and as per approved drawings.

Requirement for provision of the luminaries are as under:

Sl. No.	Location	Requirement
1.	On pipe bracket of erected pole	Directly on bracket including wiring from Junction box as required
2.	On wall of the Building	On wall including supply and grouting of 600 mm long GI pipe bracket and wiring from light point as required
Normally Sl. 2 of above type should be avoided.		

14.7.6 All fittings/fixtures viz. ceiling fans, exhaust fan, MCB etc. which have not been specifically covered shall conform to the latest IS specification and their brand, capacity, details etc. shall be got approved from Engineer.

14.7.7 Outdoor weather proof L.T. outlet for oil filtration of Transformers at each TSS, RSS, SP and SSP. One outlet at each location of each traction/Auto/Power transformer, housed in a weather proof box, heavy duty industrial type for outdoor use shall be provided for supply to transformer oil filtration machine.

14.8 Corrosion Protection

All ferrous components and fittings exposed to the atmosphere shall be hot-dip galvanized as per the relevant IS

14.9 Testing and Commissioning

Prior to commissioning, on completion, all works including wiring, electrical fittings and appliances shall be tested jointly Engineer in accordance with IS:732 (Latest version) and commissioned. Records of all tests conducted along with the drawings for the wiring shall form record as built drawings.

- END OF CHAPTER -

15. Anti Theft Charging of OHE

15.1 As an anti-theft measure, the OHE after erection may be charged at 2.2kV by the Contractor. However, before such anti-theft charging safety of Personnel of all the contractors and of Employees of adjacent Railway System has to be ensured. This includes:-

a) Permission of the Employer.

b) E.I.G. Sanction: Appointment and Placement of authorised personnel.

c) Issue of public notice in Local Newspapers for information to public.

d) Notice to adjacent Indian Railway Administration.

e) Procedure providing for issue and cancellation or permit to work on or in vicinity (within two meters of the conductors & 25 KV equipment) to all concerned through and to authorized Personnel as a requirement before the lines can be charged to provide anti-theft. The list of authorized Personnel shall be approved by the Engineer and provided to all the concerned authorities.

f) Control Room for 24X7 hour monitoring of the charged sections and its patrolling. Communication facility to enable monitoring of the OHE and management of Permit TO Work (P.T.W.).

g) Issue of certificate to authorized Personnel for charge & discharge of line.

h) Communication with patrol party and control room.

i) Attending to alarms.

15.2 The contractor will give notice to all the designated Contractors, who will take necessary precaution while carrying out the works keeping in view the anti-theft charging of OHE. This antitheft charging shall not be done until no objection is received from the Engineer and confirmation received from him that IR staff have been warned of the hazards of adjacent line of DFC being charged and have been trained on the precautions required to be taken by them.

15.3 Detailed rules shall be prepared by the Contractor and put up to the Engineer for approval & issue to all concerned.

- END OF CHAPTER -

16 Civil Works at RSS/TSS & Switching Posts

16.1 General

16.1.1 This chapter deals with details in specifications for design and construction of Civil Engineering Works for RSS/TSS and Switching Stations. This Chapter also gives reference to technical specifications of materials, components, procedure of design and drawings for above works.

16.1.2 The contractor will design the plan of all the control buildings for RSS/TSS/Switching Station to be constructed based on footprint of equipments, maintainability operational flexibility etc. and take approval of the engineer. The indicative build up area of the buildings is given as below:

SN	Buildings	Approx. Area
1.	Control building of RSS/TSS	2 x 205 sq. m OR 400 sq.m
2.	Control building of SP	55 sq. m
3.	Control building of SSP	45 sq. m

16.2 Earth Work

(a) The Earth work shall be based on Final Layout Plan for the premises giving the 75 cm above Highest Flood Level (HFL) of the Final Surface as approved by the Engineer.

(b) Before the Earth work is started, the area coming under filling shall be cleared of shrubs, rank vegetation, grass, bush wood trees and samplings of girth up to adequate depth, requires as per site condition and rubbish removed outside the periphery of the area under clearance. The roots of the trees and samplings shall be removed to a depth, as per site condition. The required holes or hollows filled up with the Earth ramped and leveled.

(c) The trees of girth shall be cut only after the permission of the Engineer.

(d) Mechanical Compaction:-Depending upon the height of the embankment, the type of soil, time available for completing the embankment and other relevant factors, Engineer shall decide whether mechanical compaction is to be done for the full or part height of embankment. Suitable method for compaction as decided by Engineer shall be adopted. Suitable drainage in the yard shall be provided to drain away rain water.

(e) Excavation: All cutting shall be taken down carefully to the precise level as advised by the Engineer. In case, the bottom of the cutting is taken down deeper than is necessary by oversight or neglect of the contractor, the hollow must be filled up to true depth with selected material and rammed, if approved by Engineer. Cuttings with the formation in rock will be excavated 15 cm below the true formation and filled up to true level with cutting spoil to ensure that no lumps of solid rock Project above formation level.

(f) Drainage of cuttings: In excavating cuttings, special precautions are to be taken to ensure that the excavations drain themselves automatically. To ensure this, the central block of Earth or gullet is to be excavated first. This will be done in such a manner that the bottom of the excavation shall where possible, slope downwards from the center of the cutting towards the ends. It will be made in such cuts or steps as may from time to time, be directed. Generally, in deep cuttings the first cut or step will approximately follow the surface of the ground where this will secure the necessary slope for drainage, and will be excavated to such depth as may be ordered, with perpendicular sides leaving pathways for workmen along the sides of the cut parallel to the central line the gullet may be cut out at once to formation level.

(g) Catch water drains: Where required, catch water drains shall be constructed on the uphill side leaving a berm of one meter from the boundary of the railway land. The cross sectional area of the catch water drain shall normally not exceed 0.75 sq.m. The spoil from the catch water drain will be thrown up on the side towards the cutting.

(h) Berms and spoil banks: No spoil shall be deposited within a distance of 6m from the top edge of the slope of any cutting.

(i) The spoil heap shall be roughly but neatly dressed off to a slope of 1-1/2:1 and shall form a continuous band along the top of the cutting.

(j) All material excavated from cutting suitable for pitching, ballast, masonry or any other purpose whatever, and shall be disposed of in a manner as directed by the Engineer.

(k) Springs or Inflow: Should springs or inflow of water appear in cuttings, or should they be flooded, the contractor must arrange for bailing, pumping or drainage of water, without obstruction to adjacent works.

(l) Suitable anti-weed treatment shall be carried out by the Contractor as per I.S.

16.3 Cement

16.3.1 Cement Grade 43/53 (OPC/PPC) conforming to IS 8112/1489 shall be used by the Contractor. Cement for use in the works shall be procured by the contractor from the main producers or their authorized dealers only. Cement older than 3 months from the date of manufacture as marked on the bags shall not be accepted.

16.3.2 Quality test certificate for cement as per IS: 4031 shall be furnished by the contractor at his own cost before use.

16.4 Building Materials

16.4.1 Building materials if not already specified above, shall be used in accordance with relevant IS code and as specified in CPWD Specification.

16.5 Cable Trench & Water Drainage

16.5.1 Cable Trench & Water Drainage shall be provided in the yard. It will have a gradient to discharge the water. Cable trench provided in the control room may not have any gradient as it will not discharge any water.

16.6 Foundations

16.6.1 Foundations shall be designed by the contractor in accordance of this tender document. Clause 8.15.2, 8.15.3 and 8.15.4 may be referred for guidance. The contractor shall get the relevant drawings approved by the Engineer. The foundation work may involve wet excavation also, for which all due precautions by way of pumping and other operations, preventing blowing are to be adopted.

16.6.2 **Plinth Filling**

Plinth filling shall be done with Earth in 15cm layers, duly consolidated, watered & rammed unless otherwise specified. In black cotton soil, the soil shall be removed for a depth of 60 cm and top 30 cm filling shall be done with sand.

16.6.3 Wherever it is necessary in case of deep trenches, shoring or timbering for such trenches shall have to be provided to avoid collapsing of Earth.

16.6.4 **Apron**

For protection of plinth, an apron as specified by the Engineer shall be provided.

16.7 Special Foundations

16.7.1 In case foundations, not covered by the schedules furnished by the Employer, the contractor shall prepare special designs and furnish full design calculations justifying the choice of the type of foundations for such locations and get approval from Engineer.

16.8 Building

16.8.1 The building shall be of brick work constructed with RCC roof and steel doors, windows and ventilators. The ancillary equipment for ATS shall be housed in a weather proof concrete hut as required.

16.9 Reinforcement

16.9.1 Reinforcement may be either TOR/TMT Steel or mid steel bars comprising to relevant I.S. Before use, contractor will be required to obtain test certificate for the accuracy of quality of reinforcement used at his own cost from the laboratory/institute approved by the Engineer.

16.10 Reinforced Cement Concrete Work

16.10.1 R.C.C. of the Switching Station shall be cast on the controlled concrete technology for minimum M-20 grade conforming to IS: 456. The design of all R.C.C. work shall be prepared by the contractor and got approved from Engineer well in time. Test concrete specimen shall be casted at the site work and tested in accordance with the relevant specification.

16.10.2 If unavoidable due to site conditions, concrete may have to be laid in water as per laid down procedure.

16.11 Super Structures

16.11.1 **Brick Work**

Besides following relevant specification, well burnt bricks shall only be used. The brick work below plinth shall be done in Cement mortar of ratio 1:4 (1Cement, 4 Sand). The brick work above plinth shall be done in cement mortar of ratio 1:6 Curing of the brick work shall be done for a minimum period of fourteen days.

16.11.2 Plastering on inside and outside surface shall be down in Cement mortar of ratio 1:3 and shall have a thickness of minimum 10mm.

16.11.3 All external surfaces shall be treated with Snowcem over two coats of cement primer of approved quality and all internal surfaces of wall and ceiling shall be white washed with three coats.

16.12 Roofing

16.12.1 R.C.C. roof, complete in all respects in accordance with RDSO drawing No. ET/C/0067 (or latest version) shall be provided. Water proofing of roof shall be responsibility of the contractor. Type of water proofing treatment if required, will be got approved from the Engineer. The contractor shall ensure at the time of handing over of the building that roofs are leak proof and water tight. The contractor shall also provide C.I. rain water pipes of specified size.

16.13 Flooring

16.13.1 Following pattern of the flooring shall be adopted:

(i) Base Concrete – 100 mm thick cement concrete of ratio 1:4:8 with under layer of 100 mm thick sand filling over well compacted Earth.
(ii) Top layer – 40mm thick cement concrete of ratio 1:2:4 laid in panels with glass dividing strips of 25mm x 3mm.

16.13.2 Suitable anti-termite treatment, pre and post treatment as approved by the Engineer shall be provided.

16.14 Doors, Windows, Ventilators

16.14.1 Pressed steel doors, windows, ventilators and grills etc. shall be provided in accordance with the relevant I.S. All steel work shall be painted with two coats of ready mixed paint of approved quality and shade over a base of two coats of Red Oxide primer. Large window panes shall be used for better view of yards from control buildings of RSS/TSS.

16.15 Toilet/Sewage/Pump

16.15.1 A toilet shall be provided with sanitary fittings & water supply. Disposal of night soil leaded to a pit designed for this purpose. A single phase electric pump shall be provided with water storage tank of optimum capacity. A hand pump shall also be provided nearby making a small portion pucca under the discharge. This facility shall be applicable only for RSS and TSS. All details / scheme shall be made after the approval of the Engineer.

16.16 5T Loading & Unloading Gantry for RSS and TSS

16.16.1 A gantry for loading/unloading of weight of up to 5 tonnes with chain pulling block system over an unloading platform, having road access shall be provided in each RSS and TSS. Suitable design for the same shall be prepared by the contractor and got approved for Engineer.

16.17 Spreading of Gravels

16.17.1 On top surface of finished ground, Spreading of “4” gravels on surface of outdoor yard of RSS, TSS, SP and SSP will be carried out by the Contractor as a final level. Gravels shall confirm to latest relevant I.S.

16.18 Fencing Posts and Fencing

16.18.1 Fencing shall be 2.8m above ground with anti-climbing device at the top. The design on fencing shall be approved by the Engineer.

16.18.2 Foundations for fencing posts shall rest on consolidated soil, if the depth of unconsolidated soil is less than 1.5m below the datum level and shall be rectangular parallel piped in shape. If the depth of unconsolidated soil is more than 1.5m, the foundation block shall rest on reinforced concrete pillar cast at site or reinforced concrete foundation may be adopted.

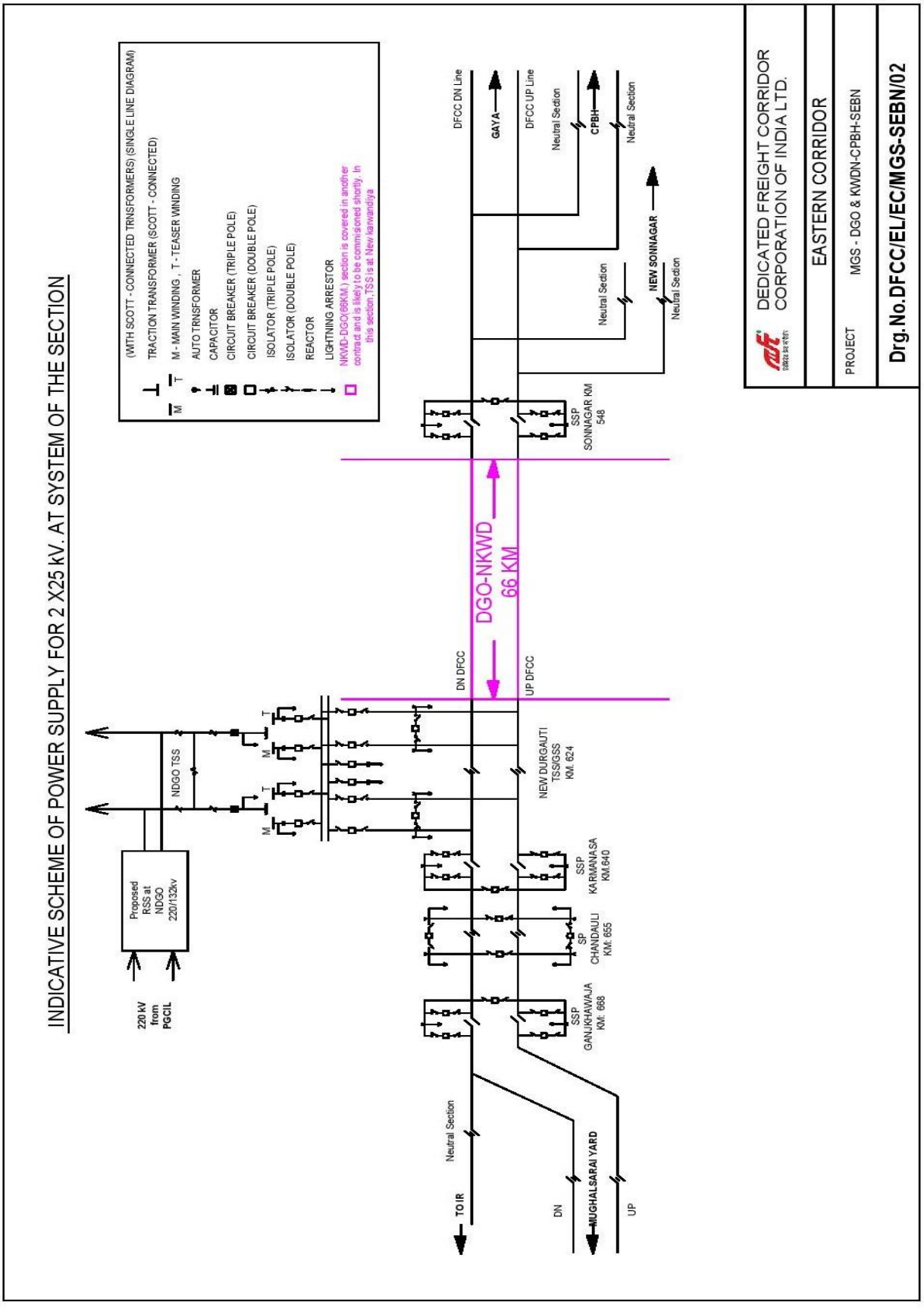
16.19 Painting

Contractor shall prepare surface thoroughly and get it cleared before actual painting. Paint of approved quality shall be used after approval from Engineer.

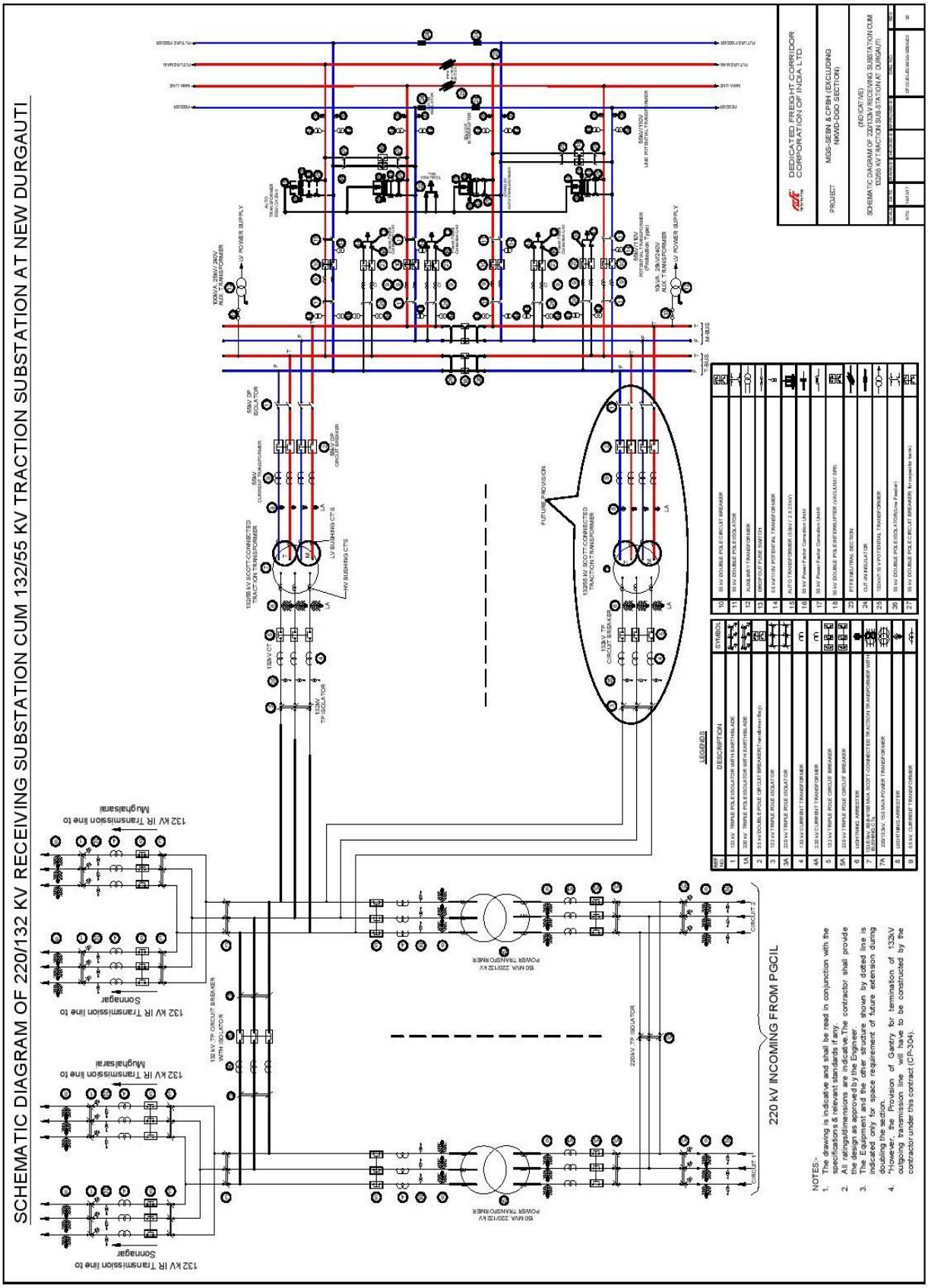
16.19.2 Only standard/reputed brand of paints and primers as per relevant ISI code and as approved by the Engineer shall only be used for painting of steel work. The work shall be carried out in accordance with CPWD specification.

- END OF CHAPTER –

APPENDIX - A


INDICATIVE SCHEME OF POWER SUPPLY FOR 2 X25 kV. AT SYSTEM OF THE SECTION
(WITH SCOTT - CONNECTED TRNSFORMERS) (SINGLE LINE DIAGRAM)
TRACTION TRANSFORMER (SCOTT - CONNECTED)
M - MAIN WINDING , T - TEASER WINDING
AUTO TRNSFORMER
CAPACITOR
CIRCUIT BREAKER (TRIPLE POLE)
CIRCUIT BREAKER (DOUBLE POLE)
ISOLATOR (TRIPLE POLE)
ISOLATOR (DOUBLE POLE)
REACTOR
LIGHTNING ARRESTOR
NKWD-DGO(66KM.) section is covered in another contract and is likely to be commisioned shortly. In this section TSS is at New karwandiya
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.
EASTERN CORRIDOR
PROJECT MGS - DGO & KWDN-CPBH-SEBN
Drg.No.DFCC/EL/EC/MGS-SEBN/02
220 kV from PGCIL
Proposed RSS at NDGO 220/132kv
NDGO TSS
DGO-NKWD 66 KM
DN DFCC
UP DFCC
DFCC DN Line
DFCC UP Line
GAYA
CPBH
NEW SONNAGAR
Neutral Section
SSP SONNAGAR KM 548
NEW DURGAUTI TSS/GSS KM. 624
SSP KARMANASA KM.640
SP CHANDAULI KM. 655
SSP GANJKHAWAJA KM. 668
TO IR
DN
UP
MUGHALSARAI YARD

APPENDIX-B

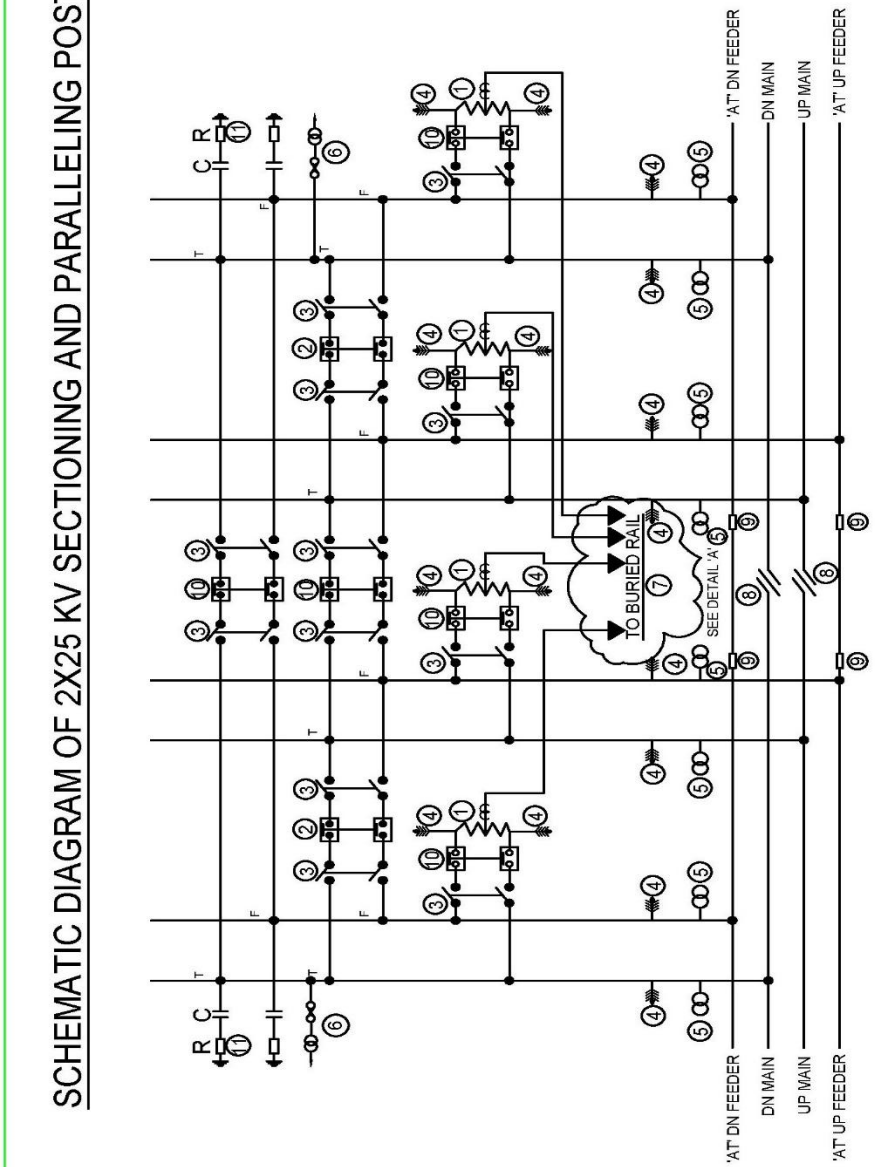

SCHEMATIC DIAGRAM OF 220/132 KV RECEIVING SUBSTATION CUM 132/55 KV TRACTION SUBSTATION AT NEW DURGAUTI
DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.
PROJECT
MGS-SEBN & CPBH (EXCLUDING NKWD-DGO SECTION)
(INDICATIVE)
SCHEMATIC DIAGRAM OF 220/132kV RECEIVING SUBSTATION CUM 132/55 KV TRACTION SUB-STATION AT DURGAUTI
LEGENDS
DESCRIPTION
SYMBOL
220 kV INCOMING FROM PGCIL
132 kV IR Transmission line to Sonnagar
132 kV IR Transmission line to Mughalsarai
NOTES:-
1. The drawing is indicative and shall be read in conjunction with the specifications & relevant standards if any.
2. All ratings/dimensions are indicative.The contractor shall provide the design as approved by the Engineer.
3. The Equipment and the feeder shown by dotted line is indicated only for space requirement of future extension during doubling the section.
4. "However, the Provision of Gantry for termination of 132kV outgoing transmission line will have to be constructed by the contractor under this contract (CP-304).

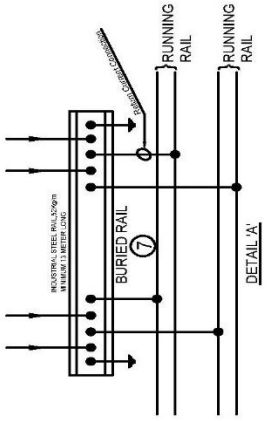
APPENDIX - C

SCHEMATIC DIAGRAM OF 2X25 KV SECTIONING AND PARALLELING POST (SP)

LEGENDS

S.NO	SYMBOL	DESCRIPTION
1.		AUTO TRANSFORMER WITH BUSHING CT
2.		2 X 25 kV DOUBLE POLE INTERRUPTER
3.		2 X 25 kV DOUBLE POLE ISOLATOR
4.		LIGHTNING ARRESTOR
5.		25 : 1 kV POTENTIAL TRANSFORMER
6.		AUXILIARY TRANSFORMER 10 kVA, 25kV/240V WITH DROP OUT FUSE
7.		BURIED RAIL
8.		PTFE NEUTRAL SECTION
9.		CUT-IN INSULATOR
10.		2 X 25 kV DOUBLE POLE CIRCUIT BREAKER ALONG WITH PROTECTION CT & PT AS REQUIRED





DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.

EASTERN CORRIDOR

PROJECT MGS - DGO & KWDN-CPBH-SEBN

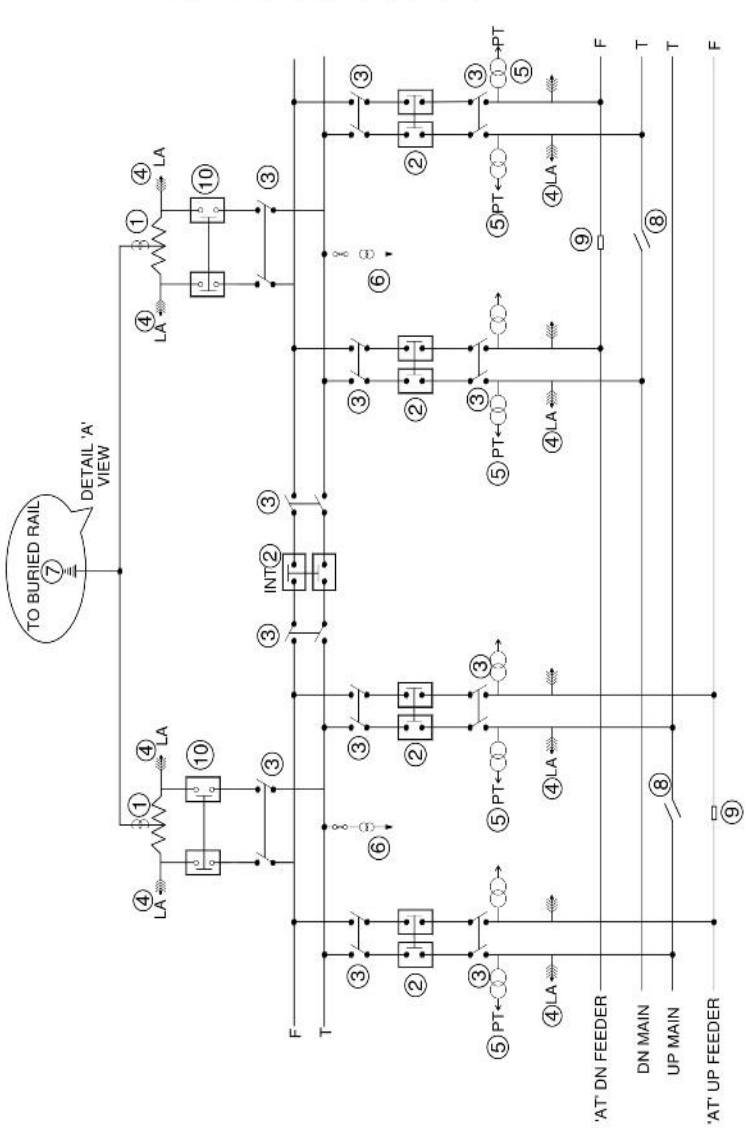
Drg.No.DFCC/EL/EC/MGS-SEBN/04

NOTES:-

1. The drawing is indicative and shall be read in conjunction with the specifications & relevant standards if any.
2. The busbar inside the SP shall be rigid type.
3. All ratings/dimensions are indicative.The contractor shall provide the design as approved by the Engineer.

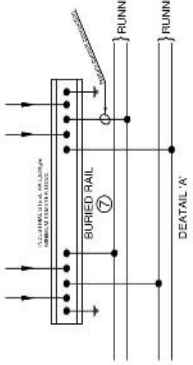
APPENDIX - D

SCHEMATIC DIAGRAM OF 2 x 25 kV SUB-SECTIONING AND PARALLELING POST (SSP)



LEGENDS

S.NO	SYMBOL	DESCRIPTION
1.		AUTO TRANSFORVER WITH BUSHING CT
2.		2 X 25 kV DOUBLE POLE INTERRUPTER
3.		2 X 25 kV DOUBLE POLE ISOLATOR
4.		LIGHTNING ARRESTOR
5.		25/110V POTENTIAL TRANSFORMER
6.		AUXILIARY TRANSFORMER 10 kVA, 25kV/240V WITH DROP OUT FUSE
7.		BURIED RAIL
8.		INSULATED OVERLAP
9.		CUT-IN INSULATOR
10.		2 X 25 kV DOUBLE POLE CIRCUIT BREAKER ALONG WITH PROTECTION CT & PT AS REQUIRED.



DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD.

EASTERN CORRIDOR

PROJECT MGS - DGO & KWDN-CPBH-SEBN

Drg.No.DFCC/EL/EC/MGS-SEBN/04

NOTES:-

1. The drawing is indicative and shall be read in conjunction with the specifications & relevant standards if any.
2. The bus bar inside the SSP shall be rigid type.
3. All ratings/dimensions are indicative.The contractor shall provide the design as approved by the Engineer.

17 Operation and Maintenance Documentation

17.1 General

17.1.1 The Contractor shall provide Operation and Maintenance manuals, for use by supervisory, operating and technical staff of Employer. Operation and Maintenance Manuals shall be supplied in English and Hindi versions.

17.1.2 Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps.

17.1.3 Information shall be provided in pictorial form, wherever possible and shall include step-by-step instructions and views of the particular equipment including exploded views. Programmable equipment shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and system modification to be undertaken at any time.

17.1.4 The Contractor shall provide clarifications and amendments to the Operation and Maintenance manuals as necessary during the Defects Liability Period. Updates shall be provided for the originals and all copies.

17.1.5 For the avoidance of doubt, operations and maintenance manuals shall be specifically written for describing the equipment as installed and modified and shall NOT be a collection on manufactured catalogues.

17.1.6 The Operations and Maintenance Manuals shall be supplied in electronic format loaded on ruggedized tablet computers. These will be taken to site by the site maintenance teams.

17.2 Operation Manuals

17.2.1 The Contractor shall provide operation manuals explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings and any necessary operating limits of the Equipment and Sub-systems shall be provided. The Operation Manuals shall focus on operation aspects under normal and emergency conditions.

17.3 Maintenance Manuals

17.3.1 The Contractor particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

17.3.2 The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements. Such documents shall include but not be limited to:

(i) Manufacturers' documentation supplied as standard with the equipment;

(ii) Hardware configuration with details of expansion capabilities and options;

(iii) Programme loading instructions, including runtime environment configuration;

(iv) Programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software;

(v) Flow charts, data flow diagrams and state diagrams as appropriate;

(vi) Description of software modules including purpose, linkage with other modules, error routines and any special considerations;

(vii) Memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like;

(viii) Loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and

(ix) Programming manuals relevant to operating systems, languages, development tools, etc.

17.3.3 The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the Employer's Personnel.

17.3.4 The maintenance manual shall also include an illustrated parts catalogue of all plant supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance staff. The catalogue shall comprise 3 sub-sections.

17.3.5 The first shall be an alphanumeric parts list, which shall include the following information:

(i) Part number

(ii) Description with drawing no. and specification no. etc.

(iii) Name of manufacturer with address/contact details.

(iv) Quantity and Unit

(v) Date of installation.

(vi) Testing log with date and results if any

(vii) Part number of next higher assembly (usually a line replaceable unit).

(viii) Cross-reference to figure number.

(ix) Category: e.g. consumable, line replaceable unit, repairable.

(x) Life-expected life, Mean time between failure or mean distance between failure, where available.

(xi) General or specific purpose

17.3.6 The second is a series of illustrations to indicate the location of each replaceable item, which shall be clear and progressive with exploded views to enable parts to be identified easily by cross-reference with the alpha-numeric list.

17.3.7 And the third an indicative price list which shall list in alpha-numeric sequence the part number with the price, lead time and vendor.

17.4 Quantity of Manuals

17.4.1 The Contractor shall supply Original plus five hard copies of Operating Manuals; Maintenance Manuals and Subsystems/Systems spare parts catalogue. These Manuals and Catalogue shall also be submitted in **Electronic Format.**

17.4.2 The format of the electronic copies shall be proven in at least two other applications and shall allow for links between parts catalogue and maintenance instructions.

17.4.3 The Documents Management System shall be subject to Employer's Personnel review.

- END OF CHAPTER -

18 Interface Management System

18.1 General

18.1.1 This chapter outlines the Contractors' interface requirements between System Contractor, other Contractors, Indian Railways, State Authorities and PGCIL; which are based on the Technical Studies carried out during the early stages of the Project.

18.1.2 The Contractor shall maintain a close interface with relevant authorities, contractors and agencies to ensure the time bound completion of the project and to ensure that all requirements of the General Specification and Particular Specification pertaining to interfaces are fully resolved and implemented.

18.1.3 The contractor shall co-ordinate with both sides system contractor for interface of the section for completion of the project.

18.1.4 The contractor shall coordinate with system contractor of EDFC-1 and NKWD-DGO section for integration/upgradation of present SCADA system for commissioning of SCADA of complete section MGS to SEBN and CPBH at OCC/ALD.

18.1.5 The contractor shall also co-ordinate with PGCIL for obtaining 220 kV power at New Durgauti RSS. The contractor shall also coordinate with IR for LILO arrangement at 132 kV from New Durgauti GSS.

18.1.6 The Interface described in this document is for reference only. It remains the Contractors' responsibilities to develop, update and execute jointly an "Interface Management Plan" (to be submitted within 45 days of award of the contract) for defining responsibilities and to exchange information in order to achieve the interface requirements before the commencement of the Works and throughout the execution of Works, to ensure that:

- All interface issues between the Contracts are satisfactorily resolved;
- Supply, installation testing & commissioning, operation and maintenance of equipment are fully coordinated; and
- All equipment and facilities supplied under the Contracts are fully compatible and integrated with each other, whilst meeting the requirements of the respective Specifications.

18.2 Interface Matrix

The indicative interface matrix shall be as under:

Indicative Interface Matrix

18.2.1 Indicative Interface Matrix for Design and Built Contractor (civil) and Designated contractors

SN	Item	Civil Contractor	System Contractor
1	OHE,PSI Installation layout & drawing	Shall submit copy of final alignment drawing including Rail level to System Contractor.	Use appropriate layer of drawing submitted by Civil Contractor and incorporate layer for OHE, PSI installation.
2	Construction of OHE	Shall provide working chainage and suitable access date to System Contractor for OHE construction work. Rail level shall be marked on fixed structure such as IR mast, in every Km.	To design and install OHE and suitable anchoring arrangements. Rail level marked on fixed structure, shall be transferred to every foundations with help of leveling instrument.
3	Construction of drain to skirt the foundation through a smooth curve so as not to infringe flow.	Shall skirt the foundations of OHE structures as advised by System Contractor wherever required.	To repair/ modify drains already constructed to avoid infringement of flow of storm water due to OHE structure related foundation work.
4	Construction of cable trough and trench	Shall co-ordinate with System Contractor for passage of the troughs & trenches required for electrical works.	Shall design and construct all power cable troughs & trenches in co-ordination with Civil Contractor.
5	Design of OHE at critical location	To provide details of bridges, ROBs FOBs and RFO.	Design and build OHE in this section including proper sectioning and earthing system for safety and ease of operation.

18.2.2 Indicative Interface Matrix with Civil and Track Contractor

SN	Item description	System contractor	Civil Contractor	Track Contractor
1	General Power supply work (E&M) for stations, cabins and staff quarters.	Interface matrix as given in Annexure XI to be followed in coordination with civil contractor.	Interface matrix as given in Annexure XI to be followed	NA
2	Track Crossing of cables/feeder	System contractor will coordinate with civil contractor for the requirement for cable crossings.	Shall provide the space for cable crossing at desired location	
3	Final alignment Drawings of Formation and Track	For OHE work central line of track including Rail level would be taken from track contractor	NA	He will give the central line of track and Rail level to system contractor for mast foundation and other erection.
4	Structures on bridges/RFOs	System contractor will make OHE lay out considering the holes/ foundation bolts already provided on the bridges/RFOs by civil/bridge contractor.	He will provide necessary holes/ foundation bolts for OHE structures on bridges, via-duct and RFOs.	NA
5	Time scheduling and construction access	The track contractor shall be doing mechanized track laying as per scheduled plan approved by PMC. System contractor shall devise his work plan as per those agreed time schedules. He shall also advise the minimum time required for execution of work after obtaining access to the site.	NA	Track Contractor shall provide construction access to facilitate the working of system contractor as agreed by track contractor with the approval of Engineer.
6	Earthing and bonding	System contractor will provide earthing and bonding for track, bridges, via ducts and RFOs in coordination with Track contractor	Will coordinate with system contractor	Will coordinate with system contractor

SN	Item description	System contractor	Civil Contractor	Track Contractor
		and civil/bridge contractor.		
7	Earthing and bonding at bridges/via-duct - concrete	System contractor will provide earthing and bonding for track, bridges, via ducts and RFOs in coordination with Track contractor and civil/bridge contractor.	Will provide dedicated reinforcement earth bars in concrete to ensure earth continuity as per approved scheme. Shall supply and install brought-out connections viz. terminal plates on every Pier cap and on consecutive span of viaduct to ensuring earthing & bonding connection with BEC.	Will coordinate with system contractor
8	Traction bonding	To design track earthing & bonding arrangement and install such bonds and co-ordinate with civil contractor.	Shall co-ordinate with system contractor.	Shall co-ordinate with system contractor.

18.2.3 Indicative Interface Matrix with IR

SN	Item Description	System Contractor	Indian Railway
1	Power Supply Interface at Junction stations with IR at Mughalsarai, Chirailapathu, BaghaBishunpur and Ganjkhwaja	The neutral section at junction stations will be provided to segregate the power supply.	OHE works pertaining to yard modification of IR will be carried out by IR. IR will allow access and necessary power blocks to interface the DFC lines with the yard lines of IR at Chirailapathu, BaghaBishunpur and Ganjkhwaja.
		PTFE Neutral section will be provided on DFC lines at Chirailapathu, BaghaBishunpur and Ganjkhwaja.	

18.2.4 Indicative interface matrix with system contractor of EDFC-1 (CP-104) for OCC

Item No.	Item Description	System Contractor	System Contractor (CP-104) of EDFC – 1
1.	Space Requirement separately for Traction and Non-Traction SCADA equipment in OCC	Shall provide information, drawing & details for space require for Traction and Auxiliary SCADA equipment, SCADA room, Operator Workstations as required. Shall make close coordination, check and confirm suitability	Shall coordinate and interface to finalize the space requirement for Traction and Auxiliary SCADA Room, Operator Workstations and make the provision for the same.
2.	Cable Route (for Traction and Non Traction SCADA)	Shall provide requirement of cable route and support for communication connectivity between various Traction and Auxiliary SCADA equipment and power distribution to SCADA equipment. Shall supply communication cables & power cables.	Shall allocate a dedicated cable route separately for Traction SCADA and Separately for Auxiliary SCADA. The contractor shall install support (metallic tray, conduit etc.) for communication connectivity between various SCADA equipment and power distribution to SCADA equipment as per the requirement of Contractor (MGS-SEBN).
3.	UPS supply for Traction and Auxiliary SCADA system	Shall share the details on SCADA Power supply requirement Shall extend UPS supply, including laying of power cables, and connections to as required	Shall coordinate with Contractor (MGS-SEBN) and arrange General Power Supply and UPS power supply for SCADA. Shall provide cable routes and cable supports
4.	Earthing	Shall coordinate for the provision of earth with Clean Earth station for use of SCADA. Shall connect SCADA's equipment with MET (clean earth) as per approved schematic.	Shall provide the clean earth system for use of SCADA system.
5.	Furniture at OCC	Shall issue layout plan of SCADA equipment and SCADA furniture and work stations etc. Shall issue details on requirement of cable gallery; cable shaft/ Niche and false floor below equipment's if any. Shall provide the required Furniture as per Particular Specifications electrical.	Shall provide space in theatre room as required byContractor (MGS-SEBN)

Item No.	Item Description	System Contractor	System Contractor (CP-104) of EDFC – 1
6.	Lighting and power	Shall interface for any special requirement or preferred location of light fixture mounting and power socket.	Shall provide lighting system in coordination with Contractor (MGS-SEBN)
7.	Ventilation & Air-conditioning	Shall furnish equipment heat – load details, along with equipment layout	Shall review the heat load. Shall design Ventilation and Air-condition System for OCC theatre accommodating requirement of this section.

18.2.5 Indicative Interface Matrix with Supply authority

SN	Item Description	System Contractor	SEB	PGCIL
1	Obtaining 11 kVs upply for DFC stations from Sub-stations of SEB including interface.	System contractor will carry out the work as per the Employer's Requirement including interface with SEB sub-station.	SEB will provide necessary shut down for execution of the work.	---
2	Obtaining 220kV supply for New Durgauti RSS from Pusauli grid of PGCIL including interface.	System contractor will carry out the work as per the Employer's Requirement. System contractor will provide gantry arrangement at New Durgauti RSS for termination of 220kV transmission line. System contractor will co-ordinate with PGCIL for protection system of RSS and transmission line.	----	PGCIL will terminate 220kV transmission line at gantry of New Durgauti RSS.

- END OF CHAPTER -

19 Supply of Spares, Tools, & Measuring Instruments

19.1 General

19.1.1 The Contractor shall supply spare parts, special tools and test equipment in accordance with the requirements of “Manufacturing, Installation, Testing and Commissioning”.

19.1.2 Spares as per table 19.2.1-1, 19.2.1-2, 19.2.1-3, 19.2.2-1, 19.2.2-2, 19.2.2-3 & 19.2.2-4 shall be supplied on the completion of Milestone 3 (as per sub-clause 8.2 of Section VII, Part 3)”

19.2 Contract Spares

19.2.1 The Contractor shall supply following items of Spares as given in following tables:

Table 19.2.1-1

Supply of OHE Spares

SN	Description	Unit	Qty.
1	2	3	4
1	Contact wire 150 mm^2*	MT	4.0
2	Catenary wire 120 mm^2*	MT	4.0
3	Aerial Earth Wire	MT	1.0
4	Dropper wire *	MT	0.5
5	Jumper wire105 mm^2*	MT	0.5
6	Jumper wire 50 mm^2*	MT	0.1
7	Large jumper wire 160 mm^2*	MT	0.5
8	Large span wire 130mm^2*	MT	0.5
9	B-series OHE Mast – all types*	Each	20
10	2x25 kV DP interrupter	Nos.	5
11	Stay tube insulator including composite type*	Nos.	75
12	Bracket Tube Insulator including composite type*	Nos.	75
13	9T Insulator*	Nos.	30
14	Suitable PG clamps for all kind of jumpers to catenary wire*	Each	100
15	Contact wire PG Clamp for all kind of jumpers*	Each	100
16	Contact wire splice*	Each	15
17	Catenary splice*	Each	20
18	Contact wire ending clamp*	Each	25
19	Catenary ending clamp*	Each	20
20	Large span wire ending clamp*	Each	12
21	Suspension clamp for catenary wire and feeder wire*	Each	50
22	Double Suspension clamp for catenary wire*	Each	12
23	Bi metallic part PG clamp for feeder wire and jumper*	Each	20

SN	Description	Unit	Qty.
24	Large catenary direct clamp*	Each	20
25	Complete cantilever assembly	Nos.	50
26	Section Insulator support clamp	Each	10
27	Mast bracket fitting for hook Insulator with GI Bolt & Nut &Lock Nut*	Each	25
28	Mast bracket fitting (150)with GI Bolt & Nut & Lock Nut*	Each	26
29	Mast bracket fitting (200)with GI Bolt & Nut & Lock Nut*	Each	18
30	Complete PTFE Type Neutral section assembly	No.	1
31	Anchor fittings (Welded)for portals*	Each	5
32	Guy rod fitting (Welded)for portals*	Each	5
33	Mast anchor fitting(300)*	Each	12
34	Mast Guy rod fitting(300) with GI Bolt, nut, Lock nut & washer*	Each	12
35	Adopter for 'R' Portal*	Each	4
36	Adopter for 'N' Portal*	Each	4
37	Adopter for 'O' Portal*	Each	4
38	Motorised Single Pole Isolator	No.	2
39	Backing angle*	Each	18
40	Guy rod assembly	Each	10
41	9T Adjuster*	Each	20
42	18mm single clevis assembly*	Each	10
43	Guide tube assembly*	Each	5
44	20mm double eye distance rod 1 mtr.*	Each	8
45	Compensation plate assembly*	Each	8
46	Equalizing plate assembly*	Each	8
47	Guy rod double strap assembly*	Each	5
48	Anti-creep wire	Mtr	200
49	Anti-creep wire(65 sq. mm) ending clamp	Each	6
50	Fabricated Steel Structure O,N,R & TTC*	MT	10
51	Regulating equipment with rope and Balance weights *	Sets	4
52	Section insulator assembly	Set	3
53	PG clamp double contact wire*	Each	25
54	Feeder wire	Km	1.5
55	All types of traction bonds with fasteners	Each	100
Note:	Items marked (*) description are indicative only. The bidder shall prepare similar list with items as applicable for the system designed by him and obtain Engineer's approval before supply.		

Table 19.2.1-2

Supply of Spares for PSI

S.N.	Description	Unit	Qty.
1	Lightning Arrestor for 132 KV	Each	1
2	Lightning Arrestor for 220 kV	Each	1
3	Lightning Arrestor 42KV	Each	2
4	25KV PT Type –I, II &III	Each	2
5	All type of bus bar & ACSR conductor connectors	Each	4
6	25kV Vacuum Circuit breaker (DP)-2000A	Nos.	1
7	25kV Interrupter (DP)-2000A	Nos.	3
8	Auxiliary Transformer for Station supply	Nos.	4
9	Operating rod Insulator 25KV (SPI)	Nos.	4
10	HRC fuse 2A, 4A, 10A, 15A, 32Amp	Each	100
11	Transformer Oil	Ltrs.	220
12	Current Transformer 25 kV (1500-700/5A)	Each	1
13	Current Transformer 132 kV (400-200/5A)	Each	1
14	Current Transformer 132 kV (600-300-150/1-1-1-1A)	Each	1
15	Auto Transformer(12 MVA)	Each	1
16	DP Isolator	No.	2

Table 19.2.1-3

Supply of Spares for SCADA System

SN	Description	Unit	Qty
1	Digital Input Module	No.	3
2	Digital Output Module	No.	3
3	Digital Input card	No.	3
4	Digital output card	No.	3
5	CPU of RTU	No.	3
6	Power supply card	No.	2
7	MODEMS	No.	2

19.2.2 SPECIAL TOOLS, TESTING AND DIAGNOSTIC EQUIPMENT AND MEASURING INSTRUMENTS

Table 19.2.2-1

Supply of Tools & Plants for OHE

SN	Description	Quantity	
		Unit	Total
1	TIRF FOR 2.5/1.5 T	Each	4
2	TIRF FOR 5/3 T	Each	3
3	PULL LIFT 1.5T/3T	Each	3
4	PULL LIFT 3/4 T	Each	2
5	Come- along Clamp for catenary wire	Each	8
6	Come- along Clamp for Contact wire	Each	8
7	Come- along Clamp for Earth wire	Each	8
8	Come- along Clamp for Feeder Wire	Each	6
9	Rail Jumper with Clamps at 2M both ends	Each	30
10	Rail Jumper Extension with Clamps at 11M both ends	Each	30
11	Earthing Discharge Rod Complete	Each	14
12	Aluminium straight ladder (5 mtr.)	Each	5
13	Aluminium straight Ladder Extendable (11M)	Each	5
14	Drilling Machine (25 mm) motor driver (Radial or filter)	Each	1
15	Bench Grinder (double end) Pedestal Motor-driven (203mm dia Disc.)	Each	1
16	Portable Gas Welding cum Cutting set Cutting range 0.5-30 mm c/w cylinders, trolley, helmet etc.	Each	1
17	Hydraulic Compressor for Return conductor Splicing Zig	Each	1
18	Portable Elect. Drill machine 21mm	Each	1
19	Honda welding Generator set (100/200 amps) c/w all accessories	Each	1
20	Portable diesel Generating set KVA 240 V.A.C.	Each	2
20 A	Inflatable light tower	Each	4
21	Flood Light Fitting with 500 Watt Lamps	Each	7
22	First Aid Box	Each	3
23	Stretcher	Each	1
24	Fire Buckets 10Ltr.	Each	4
25	Portable fire Extinguisher (10 Ltr.) dry chemical power type	Each	4
26	Portable fire Extinguisher (9 Ltr.) Co_2 Type	Each	4
27	150 sq.mm Contact wire Cutter 36”	Each	2

SN	Description	Quantity	
		Unit	Total
28	Wire Cutter 12”	Each	2
29	“D” Shackle set (1”,3/4”, 5/8”, &1” One Each)	Each	10
30	Single sleeve Pulley Block 3.5” x 5/8” Groove Steel	Each	8
31	Single sleeve Pulley Block 3.5” x 5/8” Groove Fiber for drawl of cont. &cat. wire	Each	9
32	Single sleeve Pulley Block 5” x 1” Groove Steel	Each	6
33	Contact wire Twister-cum- Bender 5”	Each	4
34	Steel Sling 19mm dia with eye on both end	Each	
(a)	1 Mtr Long	Each	10
(b)	2 Mtr Long	Each	10
(c)	3 Mtr Long	Each	10
(d)	4 Mtr Long	Each	3
(e)	10 Mtr Long	Each	3
(f)	Slewing Gadget	Each	3
35	Contact wire splicing zig	Each	1
36	Copper Hammer	Each	1
37	Non metallic Hammer	Each	1
39	Micro Meter	Each	1
40	Fibre Tape 30 mtr. & 15 mtr. Each	Each	3
41	Bench Vice	Each	2
42	Engineering Ratchet.	Each	2
43	Siren Range 5 Km.	Each	1
44	Ladder Trolley	Each	4
45	DE and Ring Spanner sets suitable for Fittings being supplied	Sets	6
46	Other useful small tools for OHE as required.	Sets	6
47	Overhead line inspection with Video Recording system for current collection Test as per RDSO spec. No.TI/SPC/OHE/OLIVER/0050(01/06)	Each	1
48	Infrared thermo-vision camera, hand held, Temperature range of objects: -20 to + 500 degree celcius, Detector resolution (Minimum pixel): 75,000, IP54 or better	Each	03
49	Rail Rod Ultrasonic Height and Stagger gauge for OHE	Each	04
50	Tensile load Testing Machine for 25kV porcelain and composite insulator as per RDSO Specification no. TI/SPC/OHE/INSTEST/0090(02/2009) Rev-0 or latest	Each	02
51	Insulated ESDD conductance analyser model TEC 6500 for testing pollution level	Each	01
52	On line leakage current monitor with PC for lightning arrestor as per RDSO specification no. TI/SPC/PSI/LCMLA/0030 or latest with all accessories	Each	02

Table 19.2.2-2

Supply of Tools &Plants for OHE– Testing and Measuring Equipment

SN	Description	Quantity	
		Unit	Total
1	Megger 2500 V	Each	1
2	Digital Megger5000 V- Mains (without battery) operation & rechargeable battery operation, 20TOhms, Short circuit current 3 mA, noise rejection 3mA, Guard out parallel leakage resistance with a max error of 2%, IP65 rated & CAT IV rating, Safety-IEC1010-1, EMC-IEC61326-1	Each	3
3	Digital Megger 10000 V- Mains (without battery) operation & rechargeable battery operation, 35TOhms, Short circuit current 6 mA, noise rejection 8mA, Guard out parallel leakage resistance with a max error of 2%, IP65 rated & CAT IV rating, Safety-IEC1010-1, EMC-IEC61326-1	Each	1
4	Dynamo Meter (5.0 Tx 20 Kg.)	Each	1
5	Earth Megger – 20 kilo ohms with 1 mohm resolution with accuracy +/- 0.5%, Test Frequency: 105-160 Hz in 0.5Hz Steps, Test Current: 50mA, Maximum Output Voltage:,50Vrms, Maximum Interference: approx. 40 Volts Peak to Peak (50 Hz), Measurement Standards- BS: 7430 (1991) and VDE 0413, Part 7, Ip 54, Safety-IEC1010-1, EMC-IEC61326-1	Each	1
6	Binoculars	Each	1
7	Multi meter	Each	1

Table 19.2.2-3

Supply of Tools& Plants for PSI

SN	Description	Unit	Qty.
1	TRIFFOR 2.5/1.5 T	Each	3
2	TIRFFOR 5/3 T	Each	1
3	Barrel Pump	Each	1
4	“D” Shackles 5/8”, 1”& 3/4 one each	Each	3
5	Steal Sling 19mm dia with eye on both end		
(a)	1 Meter Long	Each	1
(b)	3 Meter long	Each	1
(c)	10 Meter Long	Each	1
6	Chain Pulley Block 3 T Cap.	Each	1
7	Single sleeve Pulley Block 3 T Cap.	Each	2
8	First Aid Box	Each	1
9	Stretcher	Each	1
10	Fire Buckets 10 Ltr.	Each	4
11	Portable Electric BLOWER	Each	1
12	Portable Electric GRINDER	Each	1
13	Portable Elect. Drill Machine 13mm	Each	1
14	Crimping Tool up to 6 sq.mm	Each	2
15	Aluminium Step Ladder 8’	Each	2
16	Aluminium Ladder 8’ with hook	Each	2
17	Aluminium Step Ladder 16’	Each	1
18	Mobile Aluminium Ladder 36’	Each	1
19	Magic Pole Ladder	Each	2
20	Earthing Discharge Rod Complete	Each	6
21	Drop out Fuse pull Rod	Each	2
22	Portable Diesel engine operated welding set 230 V	Each	1
23	1/2”sq drive socket set containing 19 sockets with 6 attachments	Each	3
24	Mains Operated Insulation Testers 5 KV	Each	1
25	Clip on tong tester (0-100 Amps,0-500 V)	Each	1
26	D.C. VOLT METER 0 – 150 V	Each	1
27	A.C. VOLT METER 0 – 500 V	Each	1
28	Digital Time Interval meter 15min – 1000seconds	Each	1
29	Digital Insulation Tester 5/2.5 K.V.	Each	1
30	Earth Megger – 20 kilo ohms with 1 mohm resolution with accuracy +/- 0.5%, Test Frequency: 105-160 Hz in 0.5Hz Steps, Test Current: 50mA, Maximum Output Voltage:,50Vrms, Maximum Interference: approx. 40 Volts	Each	3

SN	Description	Unit	Qty.
	Peak to Peak (50 Hz), Measurement Standards- BS: 7430 (1991) and VDE 0413, Part 7, Ip 54, Safety-IEC1010-1, EMC-IEC61326-1		
31	Megger 500 V	Each	1
32	Digital Megger 5000 V- Mains (without battery) operation & rechargeable battery operation, 20TOhms, Short circuit current 3 mA, noise rejection 3mA, Guard out parallel leakage resistance with a max error of 2%, IP65 rated & CAT IV rating, Safety-IEC1010-1, EMC-IEC61326-1	Each	1
33	Oil dielectric test kit- BDV 100kV with inbuilt oil temperature measurement, HV switch off time shall be <10μs, external calibrator, weight should not exceed 35 Kg, Safety – IEC1010-1, EMC-IEC61326-1 along with 6 nos. SS sampling bottles.	Each	1
34	Oil filtration Plant 200 LPH Cap.	Each	1
35	Vehicle Mounted Oil Filtration Plant 2000 LPH Capacity	Each	1
36	Insulation Tester 250 V	Each	1
37	Multi meter	Each	2
38	Auto Transformer (Variac) 5 Amp. Cap.	Each	1
39	Primary Injection Test Kit.- 2000Amps @ 3 minutes, Open circuit voltage 6V, fine adjustment knob (Variac) on control panel with inbuilt display, positive and negative buttons for coarse adjustment of current, Design of test set should be based on transformer technology and not on spire (hole) through technology for better efficiency.	Each	1
40	Transformer Turn Ratio Tester	Each	1
41	High Accuracy Power Factor Meter	Each	1
42	Secondary Injection Test Kit– Output Ac Current 250A, Ac Voltage 250V, DC Voltage 0-300V, 0-359 deg, 15-500Hz, Plotting excitation curves, Current and voltage transformer ratio test, Burden measurement for protective relay test equipment, Impedance measurement, Efficiency tests, Polarity (direction) tests, CE-marking, Weight should not exceed 20 Kg	Each	1
43	Infrared thermo-vision camera , hand held, Temperature range of objects: -20 to + 500 degree celcius, Detector resolution (Minimum pixel): 75000, IP54 or better	Each	2
44	Microprocessor Controlled multi-Dimensional Gas chromatographs for Dissolved Gas Analysis as per ETI/PSI/105 (9/87) or latest and IS-10593, IS 599	Each	1
45	Relay Testing Kits- Modular in design, 6 current source-3X60A = 3 X15A, 4 Voltage sources out of which 3 are convertible sources- 3x300V, Max compliance voltage L-N 50V and L-L 100V, Manual control LCD Touch Screen, IEC 61850 Testing Capability, Safety-IEC1010-1, EMC-IEC61326-1	Each	2
46	Cable Fault Locator- Voltage upto 0-12kV, display of end and fault distance, display at least 5” size, DC Hipot	Each	2

SN	Description	Unit	Qty.
	Function, ARM Method, Direct Thump Method, TDR Function, Sheath Test, Sheath Fault, Integrated Battery, TDR options in both operational modes, QUICK –STEPS and EXPERT MODE shall be individually programmed by customer. Fault location by the magnetic field, and sound coincidence method, Excellent acoustic characteristics (frequency range 100Hz to 1.5kHz)		
47	Circuit Breaker Analyser kit with Dynamic contact measurement facility suitable for different makes of CBs.	Each	1
48	Battery impedance test equipment	Each	1

Table 19.2.2-4

Supply of Tools& Plants for SCADA

SN	Description	Unit	Qty
1	Diagnostic kit (LAPTOP i7 of reputed brand, 1 TB Hard Disk) capable of testing all type of modules to identify faults	Each	2
2	Digital Multi-meter	Each	4
3	Tool kit consisting following: a)Brief case. b)Crimping tools. c)Complete set of screw drivers. d) Solder. e)Soldering Iron 25W. f)Disordering Pump. g)Wire cutter. h)Cutting Plier. i)Nose Plier. j)Spanner set k)Stripper l)Brush	Each	2

- END OF CHAPTER -

Annexure – I

Abbreviation

A	Amperes
AC (or ac)	Alternating Current
A/C	Air Conditioning
ABS	Automatic Block Signaling
ACB	Air Circuit Breaker
ACS	Access Control (Rail System)
ACSR	Aluminum Conductor Steel Reinforced
ACTM	Alternating Current Traction Manual
AF	Audio Frequency
AFTC	Audio Frequency Track Circuit
AHU	Air Handling Unit
ALARP	As Low As Reasonably Practicable
AM	Automatic Mode / Amplitude Modulation
AN	Normal Air-cooled Transformer
ANSI	American National Standards Institute
APFC	Automatic Power Factor Correction
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AT	Auto Transformer
ATC	Automatic Train Control
ATD	Auto Tensioning Device
ATF	Autotransformer Feed
ATM	Automatic Train Monitoring
ATO	Automatic Train Operation
ATS	Auto Transformer Station
Aux	Auxiliary
AWG	American Wire Gauge
AWS	Automatic Warning System
AxT	Auxiliary Transformer
BG	Broad Gauge
BIS	Bureau of Indian Standards
BMS	Building Management System (Rail System)
BS	British Standard

BS EN	British Standard Euro Norm
BWA	Balance Weight Assembly
C	Celsius or Centigrade
CAD	Computer Aided Design
CB	Circuit Breaker
CBN	Common Bonding Network
CBT	Computer Based Training
CCR	Central Control Room
CCTV	Closed Circuit Television
CEA	Central Electricity Authority – Government of India
CLS	Colour Light Signal
Cm or cm	Centimeter
CMS	Control and Monitoring System
CO_2	Carbon Dioxide
COM	Communications (Rail Subsystem)
CORE	Central Organization for Railway Electrification
CPM	Critical Path Method
CPU	Central Processing Unit
Cr.	Crores
CRCA	Cold Rolled Closed Annealed
CRS	Commissioner of Railway Safety
CT	Current Transformer
CTC	Centralised Train/Traffic Control
CWR	Continuous Welded Rail
DB	Distribution Board
DC (or dc)	Direct Current
DCC	Depot Control Centre
DD	Drafts for Development
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
DG	Diesel Generator
DIN	Deutsche Industries Norm
DLP	Defect Liability Period
DOL	Direct On Line
DPR	Detailed Project Report
DRACAS	Data Reporting and Corrective Action System
DSC	Double Stack Container

E&M	Electrical and Mechanical
EI	Electronic Interlocking
EIA	Electronic Industries Association
ELCB	Earth Leakage Circuit Breaker
ELV	Essential Low Voltage
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Norm
ENV	European Pre-standard
EP	Electro Pneumatic
EPDM	Ethylene Propylene Diene Monomer
FA	Fire Alarm
FM	Frequency Modulation
FMECA	Failure Modes, Effects and Criticality Analysis
FOB	Foot Over Bridge
FOIS	Freight Operations Information System
FP	Feeding Post
FR	Fire Resistant
FRC	Fault Reporting Centre
FRLS	Fire Retardant Low Smoke
FRP	Fire Rated Proof
GC	General Consultant
GCC	General Conditions of Contacts
GETCO	Gujarat Energy Transmission Corporation Limited
GHz	Giga Hertz
GL	Ground Level
GOI	Government of India
GPS	Global Positioning System
GR	General Rules (for Train Operation on Indian Railways)
GRP	Glass Reinforced Plastic
GS	General Specification
GSEB	Gujarat State Electricity Board
GSM	Global System for Mobile Communication
GSM-R	Global System for Mobile Communication for Railway applications
HF	Human Factors
HFIP	Human Factors Integration Plan

HMI	Human Machine Interface
HO	Head Office
HRC	High Rupturing Capacity
HSCB	High Speed Circuit Breaker
HT	High Tension
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
I/O	Input/ output
IBJ	Insulated Block Joint
ICD	Interface Coordination Document
ID	Identification
IDMT	Inverse Definite Minimum Time
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers Inc.
IER	Indian Electricity Rules, 1956
IGBT	Insulated Gate Bipolar Transistor
IPR	Intellectual Property Rights
IPS	Integrated Power Supply
IR	Indian Railways
IRS	Indian Railway Standards
IS	Indian Standards
ISO	International Standards Organization
ITU	International Telecommunication Union (Formerly CCITT)
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards (Japan)
JS	Japanese Standard
JV	Joint Venture
K	Kilo
kA	kilo Ampere
Kg	Kilogram
kV or KV	Kilo Volt
kVA	Kilo Volt-Amp
kW	Kilowatt
LAN	Local Area Network
LCD	Liquid Crystal Display

LED	Light Emitting Diode
LRU	Line Replaceable Unit
LSOH	Low Smoke & Zero Halogen
LSZH	Low Smoke Zero Halogen
LT	Low Tension
LV	Low Voltage
LWR	Long Welded Rail
M or m	Meter
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MDBF	Mean Distance Between Failures
MIL	Military Standard (DoD)
MLDB	Main Lighting Distribution Board
mm	Millimeter
MMD	Maximum Moving Dimension
MMI	Man Machine Interface
MMIS	Maintenance Management Information System
MOR	Ministry of Railway
MOU	Memorandum of Understanding
MPCC	Main Power Control Centre
MPDB	Main Power Distribution Board
MS	Mild Steel
MTBF	Mean Time Between Failures
MTBR	Mean Time Between Repairs
MTRC	Mobile Train Radio Communication
MTTR	Mean Time To Repair
N	Neutral/ Newton
NBC	National Building Code of India
NC	Normally Closed
NCR	North Central Railway
NCT	Neutral Current Transformer
NEMA	National Electrical Manufacturers' Association (USA)
NF	Negative Feeder
NFPA	National Fire Protection Association (USA)
NMS	Network Management System

NO	Normally Open
NTP	Notice To Proceed
O&M	Operation and Maintenance
OCC	Operations Control Centre
OCS	Overhead Contact System
OEM	Original Equipment Manufacturer
OFC	Optical Fibre Cable
OHE	Overhead Equipment
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
PCB	Poly Chlorinated Biphenyls
PDF	Portable Document Format
PETS	Preliminary Engineering cum Traffic Survey
PF or pf	Power Factor
PFC	Power Factor Controller
Ph	Phase
PHA	Polycyclic Aromatic Hydrocarbons
PLC	Programmable Logic Controllers
POH	Periodical Overhaul
PS	Particular Specification
PSC	Pre-stressed Concrete
PSU	Public Sector Undertaking
PTR	Playback and Training Room
PTW	Permission to Work
PVC	Polyvinyl Chloride
RAM	Reliability, Availability and Maintainability
RAMS	Reliability, Availability, Maintainability and Safety
RBD	Reliability Block Diagram
RCCB	Residual Current Circuit Breaker
RCD	Residual Current Device
RDSO	Research Design and Standard Organisation (under the Ministry of Railways)
RFI	Request for Information
RITES	Rail India Technical and Economic Services
RL	Rail Level
rms	Root Mean Square
ROB	Road Over Bridge

ROW	Right of Way
RSS	Receiving Substation
RS	Rolling Stock (Rail System)
Rs.	Rupees (Indian Currency)
RSEB	Rajasthan State Electricity Board
RTU	Remote Terminal Unit
RUB	Road Under Bridge
SAP	System Assurance Plan
SAT	System Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SCP	Supply Control Post
SEM	Signal Engineering Manual of IR
SF_6 CB	Sulphur Hexafluoride Circuit Breaker
SIG	Signalling (Rail System)
SM	Station Master
SOD	Schedule of Dimension (of IR)
SOR	Station Operations Room/ Schedule of Rates
SP	Sectioning and Paralleling Post(s)
SPS	Small Part Steelwork
SPV	Special Purpose Vehicle
SQE	Safety, Quality and Environment
SR	Subsidiary Rules (for Train Operation on Zonal Railway)
SSAT	Subsystem Acceptance Tests
SSP	Sub-Sectioning and Paralleling Post(s)
SWA	Steel Wire Armoured
T&P	Tools & Plant
TBA	To be advised
TC	Track Circuit
TEL	Telephone (Rail Subsystem of COM)
TETRA	Terrestrial Trunked Radio
TOR	Terms of Reference
TOT	Transfer of Technology
TPF	Traction Power Facility(ies)
TPN	Triple Pole with Neutral
TPS	Traction Power Substation(s)
TPSS	Traction Power Supply System

TPWS	Train Protection and Warning System
TSS	Traction Substation
TVUs	Train Vehicle Units
UIC	International Union of Railways
UL	Underwriters Laboratories (U.S.A.)
UPPCL	Uttar Pradesh Power Corporation, Limited
UPS	Uninterruptible Power Supply
V	Volt
V_{acc}	Accessible Voltage
VCB	Vacuum Circuit Breaker
VDU	Visual Display Unit
VFD	Variable Frequency Drive
VVVF	Variable Voltage Variable Frequency
WB	World Bank
WSP	Wheel Slide Protection
XLPE	Cross Linked Polyethylene

Annexure - II

Definitions

Terminology	Explanation/definition
Accessible Voltage (Vacc)	The part of the rail potential under operating conditions that can be bridged by persons, the conductive path being conventionally from either hand to both feet through the body, or from hand to hand.
Autotransformer	A transformer with a single winding that is center tapped to provide a zero potential traction return connection. The +25kV terminal is connected to the catenary and the -25kV terminal is connected to the autotransformer feeder or negative feeder.
Autotransformer Station (ATS)	A building or compound containing electrical switchgear, equipment and autotransformer(s) which is arranged to connect together a number of sections of overhead line equipment.
Bonding	The electrical connection of two or more conductive parts to ensure a continuous path for electric current, or to maintain the connected parts at substantially the same potential.
British Standard	A standard published by the British Standards Institution. Its alphanumeric identity is prefixed by BS.
Common Bonding Network(CBN)	The CBN is the principle means for effecting bonding and earthing inside a building. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network in a building. These components include: structural steel or reinforcing rods, metallic plumbing, AC power conduit, cable racks and bonding conductors.
Cross-Bond	In addition to self-bond in each tunnel, the two tracks are bonded together via Traction Spider Plates.
Earth	The conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero.
Earth Electrode	A conductive part or a group of conductive parts in intimate contact with and providing an electrical connection to earth.
Earth Mat	A group of conductor rods connected together as a grid, with or without earthing electrodes normally connected at the grid points.
Earth Wire	A conductor electrically connecting together the steelwork of two or more overhead line structures or a number of overhead line small-part steelwork assemblies and bonded to a traction return rail or to the center tap of an impedance bond.
Electrical Section	A length of overhead line equipment between switching stations or between a switching station and a terminal end.
Electrification System	Electric power distribution system along track which can be on side rails or overhead and distributes power from Feeder Stations to the train's current collection system.
Employer's Personnel	The Engineer, the assistants and all other staff, labour and other employees of the Engineer and of the Employer; and any other Personnel notified to the Contractor, by the Employer or the Engineer, as Employer's Personnel.

Terminology	Explanation/definition
Equipotential Bonding	Electrical connections ensuring that exposed conductive parts and extraneous conductive parts are maintained at substantially equal potential.
European Standard	A standard published by the European Committee for Standardisation or by the European Committee for Electro-technical Standardisation. Its alphanumeric identity is prefixed by 'EN'.
Fault Current	The current that flows as a result of a unintentional electrical fault on the electrification system, such as a short circuit or flashover.
Feeding Section	A feeding section is defined as the section of overhead line between successive TSS/SP on either side of a feeder station.
First Emergency Feeding	The feeding arrangement when one of two feeder circuits to the feeder station has failed (in the case where the feeder station is fed by two feeder circuits). For feeder stations with one feeder circuit, the feeder circuit shall be used to T-feed the sections in both directions. In the latter case, normal and first emergency feeding arrangements are the same.
International Standard	A standard published by the International Electro-technical Commission. Its alphanumeric identity is prefixed by 'IEC'.
Load Current	The current that flows as a result of the operation of electric trains.
Metallic Service	A service having an exposed metallic surface, such as a gas or water pipe, a conduit, or a metal-sheathed cable.
Normal Feeding	The feeding arrangement when both 220kV feeder circuits to the Traction Sub-station are healthy and available for service. All feeder circuits shall be used to radial feed their respective sections with a neutral section between them.
Overhead Contact Line Zone	The zone whose limits are not exceeded, in general, by a live or broken overhead line conductor. The term applies to out-of-running overhead line conductors but not to those conductors that are not mechanically strained by pantographs, because the probability of breakage is too small. The profile and dimensions of the zone are defined in EN 50122-1.
Pantograph Zone	The zone whose limits are not exceeded, in general, by a live, broken or de-wired pantograph. Its profile and dimensions are defined in BS EN 50122-1.
Rail Potential	The voltage occurring between the traction return rails and earth under operating conditions and or under fault conditions.
Return Conductor	A conductor connected in series with the secondary windings of booster transformers, and bonded to the traction return rails to carry traction return current back to a feeder station independently of the running rails.
Second Emergency Feeding	The feeding arrangement when both the feeder circuits to the feeder station have failed (in the case where the Feeding Station is fed by two feeders circuits), or when the single feeder to the feeding station has failed (in the case where the Feeding Station is fed by a single feeder circuit). The affected sections are fed by the adjacent feeder stations.

Terminology	Explanation/definition
Self-Bond	In open air: One Traction Earth Wire, two running rails via traction rail spider plate, one Aerial Earth Wire and HV cable sheaths (at joint) within the same track (or same tunnel) are bonded to two Traction Spider Plates, one on each side of a track.
Simultaneous Touching Distance	The distance which can be bridged by a person. In general a minimum horizontal dimension of 2m and a minimum vertical dimension of 2.5m are adopted.
Stray Current	Electric current that follows paths other than intended paths. Stray currents occur in ac traction systems but only d.c. stray current is corrosive to steel structures.
Sub-Sectioning and Paralleling Post	A building or compound containing electrical switchgear, equipment and autotransformer(s) which is arranged to connect together a number of sections of overhead line equipment. There is also a section overlap.
Switching Station	Generic term for TSS, SSP, SP and ATP.
System Contractor	Contract of Electrification and General Electric Work awarded to the bidder is called System Contractor.
Touch Potential, Touch Voltage (V_{touch})	The electrical potential difference between two parts at different electrical potentials under fault conditions that is experienced when touched.
Traction Power Supply System	The Traction Power supply System is defined as the Infrastructure between the points of common coupling with State Power Companies.
High Voltage	Where the voltage does not exceed 33,000 volts under normal conditions subject, however, to the percentage variation allowed as per the IE Rule 1956.
Low Voltage	Where the voltage does not exceed 250 volts under normal conditions subject, however, to the percentage variation allowed as per the IE Rule 1956.
Project	Eastern Dedicated Freight Corridor from Mughalsarai to New Sonnagar and Chirailapathu (excluding New Karwandiya to New Durgauti (approx. 66 km)).
Project Wide	Project Wide is defined as Eastern Dedicated Freight Corridor Project.
Proven	The proposed System/Equipment to be used should be of proven performance and record and should have been satisfactorily in use in adequate numbers (at least 70% of the estimated quantities) in Metros, Railways or Airports during the last 3 years. The Contractor shall submit necessary proof in this regards.

Annexure - III

Climatic and atmospheric conditions

1. The system is expected to be used in varying atmospheric and climatic conditions. The environmental factors are expected to vary in the range as tabulated below:

i)	Ambient air temperature	-2.5 ^{0}C to +50 ^{0}C
ii)	Maximum temperature of metallic object under sun.	70 ^{0}C
iii)	Maximum relative humidity	75%
iv)	Annual rainfall (Most of the rainfall may be expected in the monsoon seasons)	Dry Arid regions and also heavy monsoon affected regions with rainfall ranging from 1750 to 6250mm
v)	Maximum number of thunder storm days per annum	45
vi)	Maximum number of dust storm days per annum	35
vii)	Number of rainy days per annum.	120
viii)	Basic wind pressure	150 kgf/m2, as per wind map based on BIS - 875. For long bridges (more than 150 m) and within 100 m from their abutments on either side and on banks, where the height of catenary above surrounding mean retarding surface is more than 30 meters, the specified 25% reduction in wind pressure shall not be reckoned for purposes of design.
ix)	Altitude	Not exceeding 2000m
x)	Creepage distance for Extreme pollution condition	31mm/kV

Annexure - IV

List of Indian Standards (IS)

1	5-2007	Colours for ready mixed paints and enamels.
2	102-1962	Ready mixed paint, brushing red lead non setting priming.
3	123-1963	Ready mixed paints, brushing, finishing semi gloss for general purposes.
4	226-1969, 814-1974, 816-1969, 823-1964 , 6227-1971	Code of practice for electric welding of mild steel structures.
5	269-1989 (4th rev.)	Specification for 33 grade ordinary Portland cement.
6	335-1993/BS-148, D-1473, D-1533-1934, IEC Pub 296-1969	New Insulating Oils.
7	371-1999 (3rd rev)	Ceiling Rose specification.
8	383-1970 & 515-1959	Fine & coarse aggregates for concrete.
9	432-1982	Specification for mild steel and medium tensile steel bars and hard drawn steel wires for concrete reinforcement.
10	456-2000	Code of practice for plain and reinforced concrete for general building construction.
11	694-1990/ IEC 60227	PVC Insulated cables for working voltages up to and including 1100 Volts.
12	732-1989	Code of Practice of Electrical Wiring Installations (System Voltage not exceeding 660 V).
13	743-1955	Method for determination of moisture content in greasy wool.
14	800-1984	Code of practice for use of structural steel in building construction.
15	875-1987	Code of Practice for Design Loads for Building and Structure – Part 3- Wind Loads.
16	1239-2004	Steel Tubes, Tubular and Other Wrought Steel Fittings.
17	1248-2003	Direct Acting Electrical Indicating Instruments.
18	1255-1983	Code of Practice for Installation and Maintenance of Power Cables up to and Including 33kV Rating.
19	1271-1958	Classification of Insulating Materials.
20	1293-1988/ IEC 60884-1 (2002)	Plugs and socket outlets of rated voltage up to and including 250 volts and rated current up to and including 16 amperes.
21	1393-1984	Criteria for earthquake resistance design of structure.
22	1460-2005	Automotive Diesel Fuels.
23	1554-1988/IEC 60502	PVC Insulated (Heavy Duty) Electric Cables
24	1570-1985	Stainless and heat resisting steels.
25	1576-1992	Solid pressboard for electrical purposes.
26	1646-1997	Code of Practice for Fire Safety of Building.

27	1753-1967	Aluminium conductors for insulated cables.
28	1777-1978	Industrial Luminaries with Metal Reflectors.
29	1786-1985	Specification for high strength deformed steel bars and wires for concrete reinforcement.
30	1822-1967	AC motor starters of voltage not exceeding 1000 volts
31	1866-2000	Code of practice for maintenance and supervision of mineral insulating oil in equipment.
32	1905-1980	Code of practice for structural safety of building masonry walls.
33	1913-1978	General Safety Requirements for luminaires.
34	1964-1966	Code of practices for structural safety of building foundations.
35	2026-1977/ IEC 76	Specification for Power Transformer.
36	2062-2006	Steel for general structural purpose.
37	2082/IEC 60379	Stationary storage type electric water heaters/ Methods for measuring the performance of water-heaters for household purposes.
38	2099-1986	Bushing for Alternating Voltages Above 1000V (2nd Revision).
39	2175-1988	Heat Sensitive Detectors for Use in Automatic Fire Alarm System.
40	2189-1999	Code of Practice for Installation of Automatic Fire Alarm System.
41	2208-1962	HRC cartridge fuses links up to 650 volts.
42	2309-2005	Code of practice for the protection of buildings and allied structures against lightning.
43	2312-1976	Propeller type AC ventilating fans.
44	2412-1975	Link clips for electrical wiring.
45	2502 -1963	Code of practice for bending & fixing of bars for concrete reinforcement.
46	2667-1988	Fittings for Rigid Steel Conduits for Electrical Wiring.
47	2675-1983	Enclosed distribution fuse boards, cut outs for voltage not exceeding 1000 V AC & 1200 V DC.
48	2705-1992	Current Transformers.
49	2713-1980	Specification for Tubular Steel Poles for Overhead Power Lines.
50	2834-1986	Shunt Capacitors for Power Systems
51	2927-1975	Brazing alloy.
52	3024-2006	Electrical sheet steel (oriented).
53	3043-1987	Code of Practice for Earthing.
54	3156-1992/4146-1983	Voltage Transformers/Application guide for Voltage Transformers.
55	3202-1965	Code of Practice for Climate Proofing of Electrical Equipment.
56	3231	Electrical Relays for Power System Protection.
57	3347-1967/	Dimensions for Porcelain Transformer Bushings for Use

	DIN 42531,23, 3	in Lightly Polluted Atmospheres.
58	3401-1992	Specification for Silica Gel.
59	3427-1997	Metal Enclosed Switchgear & Control Gear for Voltages Above 1000V up to and Including 52000V.
60	3480- 1966	Flexible steel conduits for electrical wiring.
61	3528-1966	Water Proof Electric Light Fitting.
62	3553-1983	Specification for Watertight Electric Lighting Fitting.
63	3639-1966	Fittings and accessories for power transformers.
64	3646-1992	Code of Practice for Interior Illumination.
65	3696-1993	Safety Code for Scaffolds and Ladders.
66	3764-1992	Excavation work- code of safety.
67	3837-1976	Accessories for rigid steel conduit for electrical wiring.
68	3842	Application guide for electrical relays for ac systems
69	3854-1997/ IEC 60669-1	Switches for domestic and similar purposes.
70	3961-1968 (Part III)	Recommended current ratings for cables.
71	3975-1999	Mild Steel Wires, Strips and Tapes for Armouring of Cables.
72	4160-1967/ IEC 60884-2-6 (1997)	Interlocking switch socket outlet.
73	4253 (Part II)	Rubber and cork.
74	4615-1968	Switch socket outlets (non-interlocking type).
75	4722-2001/BS-5000/ IEC 60034-03	Rotating Electrical Machines (2nd Revision)-2006.
76	4876-1979	Specification for hot dipped for galvanized coatings on ground steel wires.
77	4889/BS-269	Rules for Method of Declaring Efficiency and Electrical Machines.
78	4984-1985	High Density Polyethylene Pipes
79	5082-1998	Wrought Al. and Aluminium Alloys, Bars, Rods, Tube and Sections for Electrical Purposes.
80	5133-1969 (Part-I & II)	Boxes for the Enclosure of Electrical Accessories.
81	5138-1978	Enclosure construction with single sheet sturdy frame construction.
82	5216	Recommendations on Safety Procedures and Practices in Electrical Work.
83	5561-1970	Electrical power connectors.
84	5578-1984	Guide for marking of insulated conductors.
85	5613	Code of Practice for Design, Installation and Maintenance of Overhead Power Lines.
86	5621-1980	Hollow insulators for use in electrical equipment.
87	5819-1970	Recommended short circuit ratings of high voltage PVC cables.
88	5831-1984	PVC insulation and sheath of electric cables.
89	5891-1970	Recommended Short Circuit Rating of High Voltage XLPE Insulated PVC Cables.

90	6313-1981	Anti-termite treatment.
91	6380-1984	Specification of Elastomeric Insulation & Sheath of Electric Cables.
92	6474-1984	Polyethylene insulation and sheath of electric cables.
93	6600-1972 / IEC 76	Guide for Loading of Oil Immersed Transformers.
94	6655-1972	Code of Practice for Industrial Lighting.
95	6792-1992/IEC 60156	Method for Determination of Electric Strength of Insulating Oils.
96	7098-1988 (Part-I & II)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto 33kV.
97	7671-2001	Requirements for Wiring Installations. IEEE Wiring Regulations – 16th Edition.
98	7752-1975	Guide for improvement of power factor in consumer installation
99	8112-1489	Cement grade 43/ 53 (OPC/PPC).
100	8130-1984 (1st rev.)	Conductor for insulated electric cables & flexible cords.
101	8183-1993	Bonded mineral wool.
102	8468-1977	On-load tap changers.
103	8478-1977	Application guide for Tap- Changers.
104	8623-1993	Low-Voltage Switchgear and Controlgear Assemblies.
105	8632-1977	Method for identification of test-piece axes.
106	8826-1978	Guidelines for design of large earth and rock fill dams.
107	9537-1980 (Part 1)/ IEC 60614-1 (1978)	Conduits for electrical installations.
108	9900-1981/IEC 188	High Pressure Mercury Vapour lamps.
109	9974-1981/IEC 662	High Pressure Sodium Vapour Lamps.
110	10000/BS-5514	Method of tests for internal combustion engines/ Reciprocating internal combustion engines.
111	10028	Code of Practice for Selection, Installation and Maintenance of Transformers.
112	10118 (Parts 1-4)	Code of Practice for Selection, Installation and - 1982, Maintenance of Switchgear.
113	10322	Specification for Luminaries.
114	10418-1982	Drums for Electric Cables.
115	10561-1983/IEC 606	Application Guide for Power Transformers.
116	10593-2006	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis.
117	10810	Methods of Tests for Cables.
118	11353-1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
119	12021-1987	Control Transformers for Switchgear and Control gear for Voltages not Exceeding 1000 V ac.
120	12676-1989	Oil impregnated paper insulated condensers bushings-dimensions and requirements.

121	12943-1990	Brass glands for PVC cables.
122	13021-1991/IEC 60928	AC Supplied Electronic Ballasts for Tubular Fluorescent Lamps.
123	13032-1991	AC Miniature Circuit-Breaker Boards for Voltages not Exceeding 1000 V.
124	13118-1991	High-Voltage Alternating-Current Circuit-Breakers.
125	13340-1993	Power Capacitor of Self-healing Type for AC Systems Having Rated Voltage up to 650 Volts.
126	13341-1992	Requirements for Ageing Test, Self-healing Test and Destruction Test on Shunt Capacitors.
127	13364-1992	AC generators driven by reciprocating internal combustion engine.
128	13707-1993	Reliable transfer in text communication for information processing systems.
129	13779-1999/ IEC 62056	AC static watt hour meter class 1 and 2.
130	13925-1998	Shunt Capacitor for Power System.
131	13947	Specification for low voltage switchgear & control gear.
132	15787-2008/ IEC 60884-2-3 (1989)	Switch-Socket outlets (Non-Interlock Type).
133	60309-2002	Plugs, socket outlets & couplers for industrial purpose.

Annexure - V

List of International Standards (EN/BS/IEC/IEEE/ENV/ISO/UL etc.)

SN	Standard Number	Description
1	AISI 316	Austenitic Stainless Steel.
2	ANSI Z358.1	Emergency Eye Wash and Shower Equipment
3	BS 5308	Instrumentation cables – Part 1 Specification for polyethylene cables.
4	BS 6724	Specification for 600/1000 V and 1900/3300 V armoured electric cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire.
5	BS 7211	Specification for thermosetting insulated cables (non-armoured) for electric power and lighting with low emission of smoke and corrosive gases when affected by fire.
6	BS 7361 (Part 1)	Cathodic Protection - Code of Practice for Land and Marine Applications.
7	BS 7430	Code of Practice for Earthing.
8	BS 7671	Requirements for Electrical Installations.
9	BS 7835	Specification for cables with cross-linked polyethylene or ethylene propylene rubber insulation for rated voltages from 3800/6600 V up to 19000/33000 V having low emission of smoke and corrosive gases when affected by fire.
10	BS 7846	Electric cables 600/1000V armoured fire resistant cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire.
11	BS EN 50082-1	Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry.
12	DD ENV 50121 (All parts)	Railway applications - Electromagnetic compatibility.
13	DIN 7733	Laminated Products, Pressboard For Electrical Engineering, Types.
14	DIN 43138	Flexible cabled for overhead equipment and return current: Current carrying droppers of size 10 sq. mm Copper magnesium (Cu-Mg) stranded.
15	DIN 43668	Key for the doors of electrical switchgear cubicles and cabinets; double-bit key.
16	DIN 43671	Copper bus bars; design for continuous current.
17	DIN 43761	Temperature Sensors.
18	DIN 48201 (T1, T2)	Catenary wire, Copper stranded conductor (Magnesium Copper)
19	DIN 53481/1.2 (36)	Dielectric strength.
20	DIN 53504	Tensile strength.

SN	Standard Number	Description
21	DIN 53577	Compressive strength.
22	DIN EN 13601	Copper rod, bar and wire for general electrical purposes.
23	DIN EN ISO 1798	Flexible cellular polymeric materials.
24	EN ISO 1856	Flexible cellular polymeric materials.
25	EN ISO 9001	Quality systems: Model for quality assurance in design, development, production, installation and servicing.
26	EN 50119	Railway Applications - Fixed installations- Electric traction overhead lines.
27	EN 50121	Railway applications - Electromagnetic compatibility.
28	EN 50122	Railway Application - Fixed Installations, Electrical Safety, Earthing and return circuit.
29	EN 50124-1	Insulation Co-ordination in Traction Systems.
30	EN 50125-2	Environmental Conditions for Fixed Installations.
31	EN 50126	Railway applications: The specification and demonstration of dependability, reliability, availability, maintainability and safety (RAMS).
32	EN 50149	Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires.
33	EN 50152	Railway Applications- Fixed Installations - Particular requirements for AC Switchgear. (All parts).
34	EN 50160	Voltage characteristics of electricity supplied by public distribution systems.
35	EN 50162	Protection against corrosion by stray currents from direct current systems.
36	EN 50163	Railway Application - Supply Voltages of traction systems.
37	EN 50267	Common test methods for cables under fire conditions. Tests on gases evolved during combustion of materials from cables.
38	EN 50272 (Part 2)	Safety requirements for secondary batteries and battery installations - Stationary batteries
39	EN 50327	Railway applications. Fixed installations. Harmonization of the rated values for converter groups and tests on converter groups.
40	EN 50328	Railway applications. Fixed installations. Electronic power convertors for substations.
41	EN 50329	Railway applications. Fixed installations. Traction transformers.
42	EN 50388	Railway applications: Power supply and rolling stock – technical criteria for the coordination between power supply (substation) and rolling stock to achieve operability.
43	EN 60051	Direct acting indicating analogue electrical measuring instruments and their accessories.
44	EN 60073	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators.

SN	Standard Number	Description
45	EN 60076	Power Transformers.
46	EN 60137	Insulated Bushings for Alternating Voltages above 1kV.
47	EN 60146	Semiconductor converters.
48	EN 60214	On-load tap-changers.
49	EN 60255	Electrical relays.
50	EN 60269	Low-voltage fuses.
51	EN 60270	High voltage test techniques - Partial discharge measurements.
52	EN 60296	Fluids for electro technical applications. Unused mineral insulating oils for transformers and switchgear
53	EN 60332	Tests on electrical and optical cables under fire conditions. Test for a vertical flame propagation for a single insulated wire or cable.
54	EN 60417	Graphical symbols for use on equipment.
55	EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system.
56	EN 60507	Artificial pollution tests on high-voltage insulators to be used on ac systems.
57	EN 60529	Specification for the degree of protection provided by enclosures (IP code).
58	EN 60721	Classification of environmental conditions. Environmental parameters and their severities.
59	EN 60726	Dry type power transformers.
60	EN 60896-2	Stationary lead-acid batteries. General requirements and methods of test. Valve regulated types.
61	EN 60947	Specification for low-voltage switchgear and control gear.
62	EN 61034	Measurement of smoke density of cables burning under defined conditions.
63	EN 61138	Cables for Portable Earthing and Short Circuiting Equipment.
64	EN 61140	Protection against shock – Common aspects for installation and equipment.
65	EN 61230	Live Working – Portable Equipment for Earthing or Earthing and short circuiting.
66	EN 61325	Insulators for Overhead Lines with Nominal Voltages above 1000 V.
67	EN 61508	Functional safety of electrical/ electronic/ programmable electronic safety related systems.
68	EN 61952	Insulators for overhead lines. Composite line post insulators for alternating current with a nominal voltage.
69	EN 62271	High-voltage switchgear and control gear.
70	IEC Hand Book for Temperature	Cable in fire regarding temperature Index Chapter-6.

SN	Standard Number	Description
	Index	
71	IEC 68	Arrangements for the recognition and acceptance of conformity assessment results.
72	IEC 112	Guide on the safety of multimedia equipment.
73	IEC 137	Bushings for alternating voltages above 1000 Volts.
74	IEC 185	Current Transformers.
75	IEC 571	Electronic equipment used on rail vehicles.
76	IEC 641	Pre-compressed board solid.
77	IEC 540 & 540A	Test methods for insulation and sheaths of electric cables and cord.
78	IEC 1508	Functional Safety – Safety related systems.
79	IEC 10333	Cable joints and terminations.
80	IEC 60044	Instrument transformers.
81	IEC 60050	International Electro technical Vocabulary.
82	IEC 60076	Power Transformers/Reactors.
83	IEC 60081	Tubular fluorescent lamps for general lighting service.
84	IEC 60228	Conductors of insulated cables.
85	IEC 60255	Measuring Relays and Protection Equipment.
86	IEC 60269	Low Voltage Fuses.
87	IEC 60287	Calculation of the continuous current rating of cables.
88	IEC 60298	AC metal-enclosed switchgear and control gear for rated voltages above 1kV and up to and including 72kV.
89	IEC 60332	Tests on electric and optical fibre cables under fire conditions Part 1-2: Test for vertical flame propagation for a single insulated wire or cable Procedure for 1 kW pre-mixed flame.
90	IEC 60364	Electrical installations of buildings.
91	IEC 60376	Specification of technical grade Sulphur Hexafluoride (SF6) for use in electrical equipment.
92	IEC 60439	Type-tested low-voltage switchgear and control gear assembly.
93	IEC 60479	Effects of current on human beings and livestock.
94	IEC 60502	Extruded solid dielectric insulated power cables for rated voltages from 1kV up to 30kV.
95	IEC 60517	Gas-insulated metal-enclosed switchgear for rated voltages of 72.5kV and above.
96	IEC 60529	Degrees of protection provided by enclosures.
97	IEC 60598	Luminaires: General Requirements and Tests.
98	IEC 60616	Terminal and tapping markings for power transformers.
99	IEC 60694	Common specification for high voltage switchgear and control gear standards.
100	IEC 60754	Test on gases evolved during combustion of electric cables.
101	IEC 60815	Guide for the selection of insulators in respect of polluted

SN	Standard Number	Description
		conditions.
102	IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um = 36kV) up to 150kV (Um = 150kV) Test methods and requirements.
103	IEC 60850	Railway applications – Supply voltages of traction systems.
104	IEC 60853	Cyclic & emergency current rating of cable.
105	IEC 60898	Circuit-breakers for over current protection for household and similar installations.
106	IEC 60929	AC supplied electronic ballasts for tubular fluorescent lamps - Performance requirements.
107	IEC 60947-2	Low-Voltage Switchgear and control gear.
108	IEC 61000	Electromagnetic compatibility.
109	IEC 61024	Protection of Structures against Lightning, Part 1: General Principles.
110	IEC 61243	Voltage Detecting Systems.
111	IEC 61312	Protection against lightning electromagnetic impulse (LEMP).
112	IEC 61439	Low-voltage switchgear and control gear assemblies.
113	IEC 61443	Short Circuit Temp. limits for cables with rated voltage above 36kV.
114	IEC 62128	Railway applications - Fixed installations - Part 1: Protective provisions relating to electrical safety and earthing.
115	IEC 62236	Railway Applications – Electromagnetic Compatibility.
116	IEC 62271	High Voltage Switchgear and Control Gear.
117	IEEE 80	Guide for safety in ac substation grounding.
118	IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Grid System.
119	IEEE 446	IEEE Recommended Practice for Emergency and Standby Power Systems.
120	IEEE 485	IEEE Recommended Practice for Sizing of Large Lead Storage Batteries for generating Station and Substations.
121	IEEE 738	Standard for Calculating Current-Temperature of Bare Overhead Conductors.
122	IEEE 980	Guide for Containment and Control of Oil Spills in Substations.
123	IEEE 1187	Recommended Practice for Installation Design and Installation of Valve-regulated Lead acid Storage batteries for Stationary Applications.
124	IEEE 1188	IEEE Recommended Practice for Maintenance, Testing and Replacement of valve-regulated Lead Acid (VRLA) Batteries for Stationary Applications.
125	IEEE 1189	IEEE Guide for Selection of Valve-regulated Lead Acid (VRLA) Batteries for Stationary Applications.
126	IEEE 1313.1	Standard for Insulation Coordination

SN	Standard Number	Description
127	IEEE 1427	Guide for Recommended electrical Clearances and Insulation Levels in Air-insulated Electrical Power Substations.
128	IEEE C2	National Electrical Safety Code.
129	IEEE C37.14	Low-voltage DC Power Circuit Breakers used in Enclosures.
130	IEEE C37.16	Standard for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors used in Enclosures
131	IEEE C37.20.1	Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
132	IEEE C37.30	Standard requirements for High-Voltage Switches.
133	IEEE C37.32	HV switches, Bus Supports and Accessories, Schedule of Preferred Ratings, Construction Guidelines and Specifications.
134	IEEE C37.34	Standard Test Code for HV Air Switches, Insulators and Bus Supports.
135	IEEE C37.35	Guide for Application, Installation, O&M of HV Air Disconnecting and Load Interrupter Switches.
136	IEEE C37.37	Standard Loading Guide for AC HV Air switches (in excess of 1000V).
137	IEEE C37.20.2	Standard for Metal-Clad Switchgear.
138	IEEE C37.100	Definition of Power Switchgear.
139	IEEE C57.93	Guide for Installation of Liquid Immersed Power transformers.
140	IEEE C57.12.00	Standard General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers.
141	IEEE C57.12.80	Standard Terminology for Power and Distribution Transformers.
142	IEEE C95.1	Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
143	IEEE C95.6	Standard for Safety Level with respect to Human Exposure to Electromagnetic Fields 0-3 kHz.
144	IEEE PC37.2/D 2.2	Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations.
145	ISO 3864	Graphical symbols -- Safety colours and safety signs.
146	ISO 17398	Safety colours and safety signs.
147	NEC 300-21	Spread of Fire or Products of Combustion.
148	NEMA 250	Enclosures for Electrical Equipment.
149	NEMA AB1	Moulded Case Circuit Breakers and Moulded Case Switches.
150	NEMA BU1	Bus ways.
151	NEMA SG5	Power Switchgear Assemblies.
152	NEMA SG6	Power Switching Equipment.
153	NEMA TR208	Disconnect Switchgear Insulators.
154	NEMA WC70	Standard for Non-shielded Power Cables Rated 2000V or Less for the Distribution of Electrical Energy
155	NFPA	National Fire Protection Association.

SN	Standard Number	Description
156	NFPA 70	National Electrical Code.
157	NFPA130	Standard for Fixed Guide way Transit and Passenger Rail Systems.
158	UL 6	Rigid Metal Conduit.
159	UL 924	Emergency Lighting and Power Equipment.
160	UL 925	Fluorescent lamp Ballasts.

Annexure - VI

List of RDSO Specifications

Sl. No.	Specification No.	Description
1	ETI/OHE/3	Technical specification for Annealed stranded copper conductors for jumper wire for Electric Traction.
2	ETI/OHE/11	Specification for steel tubes.
3	ETI/OHE/13	Specification for Hot dip zinc galvanization of steel masts (Rolled & Fabricated), tubes and fittings used on 25kV,AC OHE.
4	ETI/OHE/16	Specification for 25kV,AC, single pole and double pole isolators for Railway Electrification.
5	ETI/OHE/18	Specification for Steel and stainless steel bolts, nuts and washers.
6	ETI/OHE/21	Aluminium alloy section and tubes for 25kV Traction Overhead Equipment.
7	ETI/OHE/27	Specification for Section Insulator assembly without sectioning insulator.
8	ETI/OHE/33	Specification for Enameled steel plates.
9	ETI/OHE/33A	Retro-Reflective structure Number Plates & Caution/ warning Boards.
10	ETI/OHE/36	Specification for Galvanized steel wire rope.
11	ETI/OHE/48	Technical specification for Winch type regulating equipment for 25kV,AC traction.
12	ETI/OHE/49	Technical specification for Fittings for 25kV ac OHE.
13	ETI/OHE/51	Specification for Discharge/earthing pole assembly for 25kV,AC traction.
14	ETI/OHE/52	Specification for Interlocks for AC Traction Switchgears.
15	ETI/OHE/53	Principles for OHE layout plans and sectioning diagrams for 25kV AC traction.
16	ETI/OHE/55	Specification for Bimetallic (aluminium-copper) strip.
17	ETI/OHE/58/1	Specification for hand operated lifting and swiveling platform.
18	ETI/OHE/64	Specification for solid core cylindrical post insulators for systems with nominal voltages of 220kV, 132kV, 110kV & 66kV.
19	ETI/OHE/65	Specification for continuous cast copper wire rods.
20	ETI/OHE/71	Code of bonding and earthing for 25kV AC 50Hz single phase traction system.
21	ETI/PSI/1	Battery charger for 110 volt battery, 40 Ah.
22	ETI/PSI/14	Technical specification for 25kV drop out fuse switch and operating pole for use with 110kVA and 100kVA, 25k/230V LT supply transformers.
23	ETI/PSI/15	Specification for 25kV/230V, 5kVA, 10kVA, 25kVA & 50kVA, 50 Hz, single phase, oil filled auxiliary transformers for Railway AC traction system.
24	ETI/PSI/15A	25kV/230V L.T. supply Transformer, 100kVA.
25	ETI/PSI/24	Battery charger for 110V Battery, 200 AH.

Sl. No.	Specification No.	Description
26	ETI/PSI/29	Low tension Distribution panels for Railway A.C traction sub-stations.
27	ETI/PSI/31	Standard for drawings for power supply Installations.
28	ETI/PSI/63	Low tension distribution panels.
29	ETI/PSI/67(11/96)	Shunt capacitor equipment for Railway traction sub-stations.
		Series reactor for 25kV AC Traction system
30	ETI/PSI/71	Metal oxide gapless type lightning arrester for use on 25kV. side of Railway traction substations and switching stations.
31	ETI/PSI/90	25kVAC 50 Hz single phase oil filled current transformers with ratio of (i) 1000-500/5A, (for general purposes), (ii) 1500-750/5 (for heavy duty).
32	ETI/PSI/97	150kVA, 25kV, single phase, 50 Hz. Dry type Cast resin Booster Transformers.
33	ETI/PSI/98	100 KVA. And 150 KVA. 25kV single phase 50 Hz, oil filled booster transformer.
34	ETI/PSI/117	Technical specification for current transformers: I. 220kV. 200-100/5A, II. 132kV. 400-200/5A, III. 110kV.400-200/5A, IV. 66kV.800-400/5A for Railway A.C traction substations.
35	ETI/PSI/118	Specification for 21.6 MVA single phase, 50 Hz. 220/27kV, 132/27kV, 110/27kV, 66/27kV traction power transformer for Railway A.C traction sub-station.
36	ETI/PSI/120	Code of practice for earthing of power supply installations for 25kV,AC, 50 Hz, single phase traction system.
37	ETI/PSI/122	Technical Specification for 245kV, 145kV, 123kV, 72.5kV, Double Pole & Triple Pole Isolator for Railway Traction Sub-Stations.
38	ETI/PSI/129	Technical specification for Distance Relay for 2x25kV feeding system for Railway AC traction substations.
39	ETI/PSI/132	25kV double pole outdoor, vacuum interrupters for Railway switching stations for 2x25kV 'AT' feeding system.
40	ETI/PSI/133	25kV AC Double Pole Isolators for 2x25kV AT feeding system.
41	ETI/PSI/135 (8/89)	'AT' booster current ration type fault locator for 2x25kV AT feeding system.
42	ETI/PSI/137	Metal oxide gapless type lightning arresters for use of 220/132/110/66kV side of railway AC traction substation.
43	ETI/PSI/138	Control and Relay Board for 2x25kV AT system.
44	ETI/PSI/144	Specification for Supervisory Control and Data Acquisition (SCADA) system for 2x25kV AT Traction power supply.
45	ETI/PSI/147	Specification for 25 kV current transformer with CT ratio 100-50/5 for shunt capacitor banks in 2x25 kV 'AT' feeding system.
46	ETI/PSI/167	25kV AC 50Hz single pole, outdoor interrupter for Railway traction switching stations.
47	RE/30/OHE/5	Specification for Copper bus bar.
48	RE/OHE/25	Standard for drawings for Traction Overhead equipment.

Sl. No.	Specification No.	Description
49	RDSO/PE/SPEC/AC/0100,(Rev.'1') - 2011	Technical Specification for Double capped tubular T5 Fluorescent lamps, T5 luminaire & Electronic ballast.
50	RDSO/PE/SPEC/PS/ 0093-2008,(Rev.'0')	Stand-Alone Solar Photovoltaic LED based street lighting system.
51	RDSO/PE/SPEC/PS/ 0094-2008 (Rev. '0')	Specification for solar based water heating system.
52	RDSO/PE/SPEC/PS/ 0123 (REV.0) -2009	Provisional Specification for energy efficient LED based luminaire unit for street light and platform lighting.
53	RDSO/PE/SPEC/TL/ 0040-2003 (Rev-0)	Specification for low maintenance lead acid batteries for 40 Amp hour and 200 Amp hour cells for traction distribution system.
54	RDSO/PE/SPEC/TL/ 0086-2009, (Rev.'0')	Technical Specification for LED Signage System.
55	TI/SCADA/TCP-IP/ SPC/12	Development of one prototype TCP-IP based Supervisory Control and data Acquisition System for 25kV single phase 50 Hz AC Traction power supply system for IR.
56	TI/SPC/LWTSI/0060	Specification for light weight section insulator assembly.
57	TI/SPC/OHE/8WDHTW/00700	Technical specification for 8 wheeler OHE inspection car 1676mm gauge.
58	TI/SPC/OHE/3PHTATD/0150 (09/2016)	Specification for Three pulley type regulating equipment with 2400 kgf tension in overhead conductor for 25kV traction.
59	TI/SPC/OHE/FRPNP/INS/COM/1070	Technical specification for silicon composite insulators for 25kV, AC, 50Hz, single phase overhead traction lines.
60	TI/SPC/OHE/GALSTB/0040	Technical specification for galvanized steel stranded wire for traction bonds for 25kV, AC Electric traction systems.
61	TI/SPC/OHE/GATD/ 0080	Technical specification for gas auto tensioning device.
62	TI/SPC/OHE/GSSW/ 0090	Schedule of technical requirements for manufacture of Galvanized steel stranded wire (GSSW).
63	TI/SPC/OHE/INS/0070	Specification of solid core porcelain insulators for 25kV A.C 50 Hz single phase overhead traction lines.
64	TI/SPC/OHE/INSTEST/0090	Specification for Testing load testing machine 25kV Porcelain & Composite insulator before installation.
65	TI/SPC/OHE/LWTSI/0060	Specification for Light Weight Section Insulators assembly.
66	TI/SPC/OHE/POST/ 0100	Specification for solid core porcelain cylindrical post insulator for systems with nominal voltage of 66kV, 110kV, 132kV &

Sl. No.	Specification No.	Description
		220kV.
67	TI/SPC/OHE/SNS/ 0000	Specification for Short Neutral Section assembly (Phase Break).
68	TI/SPC/OHE/ WR/1060	Specification for stainless steel wire rope.
69	TI/SPC/PSI/CB/0000	Outdoor Circuit Breaker for Railway AC Traction Sub-stations.
70	TI/SPC/PSI/2x25/FC&SR/ 0100	Technical specification for shunt capacitor & series reactor equipment to be used over 2x25kV traction sub-station.
71	TI/SPC/PSI/ISOLTR/ 1060	25kV, AC, Single Pole and Double Pole Motorized Isolators for Railway Traction.
72	TI/SPC/PSI/MOGTLA/0100	42 KV Metal oxide gapless type lightning arrester for use on 25 KV side & Railway Traction substation and Switching Station.
73	TI/SPC/PSI/PROTCT/1982	Specification for Delta-I type High Resistive fault selective relay for 25kVAC traction systems.
74	TI/SPC/PSI/PROTCT/2983	Specification for Panto Flashover Protection relay for 25kVAC traction System.
75	TI/SPC/PSI/PROTCT/6070	Control and relay panel for 25kV AC TSS including specification for numerical type protection relays for traction transformer, 25kV shunt capacitor bank and transmission line for 25kV AC TSS on Indian Railways.
76	TI/SPC/PSI/PTs/0990	Technical specification for 220kV or 132kV or 110kV or 66kV or 25kV potential transformer.
77	TI/SPC/PSI/VACINT/ 0040	Magnetic actuator type 25kV, AC, 50 Hz, single pole, outdoor vacuum interrupter for railway traction switching Station.
78	ETI/PSI/122(3/89)	Specification for 245/145/123/72.5kV double pole and triple pole isolators
79	TI/SPC/PSI/HVCB/ 0120 (June, 2014) Rev 0	220 kV & 132 kV Double/Triple Pole Outdoor SF6 Circuit Breakers with A & C Slip no. 1

Annexure - VII

List of RDSO Drawings

Sl. No	Brief Description	Drawing		Mod. No.
		Series	Number	
1	Standard plan Height Gauge for level crossing (for clear Span up to 7.3m) Details of structure and foundation.	TI/DRG/CIV/ HGAUGE/ RDSO	00001/05/0	--
2	Details of Height gauge for span (7.3 mtr to 10.0 mtr) with rail type for location where TVU less than 100000.	RE/CIVIL/S	146/2008	--
3	Typical location & schematic connection diagram for a three interrupter switching station.	ETI/PSI	003	C
4	Typical general arrangement of a three interrupter switching station.	ETI/PSI	004	F
5	Typical location plan & general arrangement for sectioning & paralleling station.	ETI/PSI	005	F
6	Typical location plan and general arrangement for a feeding station.	ETI/PSI	006	E
7	Details of foundation for fencing upright.	ETI/C	0032	B
8	Details for pre-cast cable trench for switching station.	ETI/C	0038	E
9	Remote Control Cubical at station, Foundation, RCC Slab, building plant and steel door.	ETI/C	0067	B
10	Protective screen of foot-over bridge and road over-bridge.	ETI/C	0068	G
11	Typical fencing and anti-climbing arrangement at switching stations.	ETI/PSI	104	E
12	Typical fencing layout at TSS (Details of Fencing panel, door, anti-climbing device etc.).	ETI/PS2	121	F
13	General arrangement & details of fencing panels & gate for switching stations.	ETI/C	0186 Sh.I& II	E
14	Typical earthing layout of sub- sectioning and paralleling station.	ETI/PSI	201	B
15	Typical Cable trench layout and foundation layout of 132/ 25kV TSS.	ETI/C	0210	F
16	Details of baffle wall at TSS (WP-112.5 Kg f/m2 and WP-75 kg f/$m^{2)}$.	E TI/C	0213	D
17	Details of RCC baffle wall at TSS (WP-150kgf/$m^{2)}$.	ETI/C	0214	B
18	Transformer oil drainage arrangement at substations.	ETI/C	0216	B
19	Arrangement for false catenary under over line structure.	ETI/OHE/SK	446	--

Sl. No	Brief Description	Drawing		Mod. No.
		Series	Number	
20	Special arrangement of OHE under over line structure.	ETI/OHE/SK	529	--
21	Typical Earthing arrangement in SPUN PSC Mast with 18mm dia. rod.	ETI/OHE/SK	537 Sh.2	B
22	Earthing and bonding of PSC mast.	ETI/OHE/SK	537 Sh.1 of 2	D
23	Arrangement of overlap.	ETI/OHE/SK	566	-
24	Typical arrangement of OHE with insulated copper catenary under over line structure.	ETI/OHE/SK	570	--
25	Schematic arrangement of un-insulated over Lap (type-I) (3 & 4 Span overlaps).	RE/33/G	02121 Sh.1	F
26	Schematic arrangement of un-insulated overlaps (3 & 4 span overlaps).	ETI/OHE/G	02121 Sh.4	A
27	Schematic arrangement of insulated overlap.	ETI/OHE/G	02123 Sh.3	A
28	Schematic arrangement of insulated overlap.	ETI/OHE/G	02131 Sh.1	
29	General arrangement of regulated OHE at turn-outs (overlaps & crossed type).	ETI/OHE/G	02141	C
30	General arrangement of regulated OHE at cross over (overlap & crossed type).	ETI/OHE/G	02151	-
31	Arrangement of neutral section.	ETI/OHE/G	02161 Sh.1	C
32	Arrangement of short neutral section.	ETI/OHE/G	02161Sh.2	-
33	Arrangement of neutral section assembly (PTFE Type) at SWS.	ETI/OHE/G	02162	-
34	Schematic arrangement of unregulated overhead equipment.	ETI/OHE/G	03101	-
35	Standard termination of OHE (Regulated & un-regulated).	ETI/OHE/G	03121 (All parts).	E
36	General arrangement of Unregulated OHE at turnouts (crossed & overlaps type).	ETI/OHE/G	03151	-
37	General arrangement of unregulated OHE at crossovers and diamond crossings (overlap and crossed type).	ETI/OHE/G	03152 Sh.1	-
38	General arrangement of unregulated OHE at diamond crossing.	ETI/OHE/G	03152 Sh.2	-
39	General arrangement of Head span.	ETI/OHE/G	03201	-
40	General arrangement of pull off.	ETI/OHE/G	03301	A
41	General arrangement of connections to OHE by copper cross feeder (150).	ETI/OHE/G	05121 Sh.1	C
42	General arrangement of connections at switching station on double track section by copper cross feeder.	ETI/OHE/G	05122 Sh.1	C
43	General arrangement of connections at switching station on multiple track section by	ETI/OHE/G	05123 Sh.1	C

Sl. No	Brief Description	Drawing		Mod. No.
		Series	Number	
	copper cross feeder.			
44	Arrangement of suspension of double spider 25kV feeder and return feeder between sub-station and feeding station.	RE/33/G	05152	C
45	General arrangement of earth wire on OHE mast.	ETI/OHE/G	05201	A
46	Arrangement of transverse bonds.	ETI/OHE/G	05251	A
47	Standard arrangement of Dropper Assembly	ETI/OHE/P	1190	-

Annexure - VIII

List of CORE Drawings

Sl. No.	TITLEOFDRAWINGS	DRAWINGNO.
1	Structural layout of 132/25kV traction sub-stations.	ETI/C/0200, SH.No.-1 (Mod-H); SH.No.-2 (Mod-D)
2	Typical cable trench and foundation lay out of 132/25kv TSS.	ETI/C/0210 (Mod. F)
3	Details of baffle wall at TSS (WP-112.5kg/sq.m) and WP (75kg/sq.m).	ETI/C/0213 (Mod. D)
4	Details of RCC baffle Wall at TSS (WP-150kg/sq.m).	ETI/C/0214 (Mod. B)
5	Line Diagram of Structural layouts of 220/25kV Traction sub-station.	ETI/C/0222
6	Structural layout of 220/27kV traction sub-station (Type-I).	ETI/C/0222-I
7	General arrangement of connections at switching station on multiple track section by copper cross feeder.	ETI/OHE/G/05123 SH.No.1 (Mod- C)
8	Characteristics of conductors/ bus bar for 25kV AC traction.	ETI/OHE/G/05600 (Mod. A)
9	Typical earthing, cable trench & foundation layout of 132/25kv TSS.	ETI/PSI/ 224 (Mod. E)
10	Typical layout of Remote Control cubicle at a switching station.	ETI/PSI/0010 (Mod. E)
11	Typical location plan and general arrangement for a feeding station.	ETI/PSI/006 (Mod. E)
12	Typical return current connection to buried rail at 132/25kv Traction sub-station.	ETI/PSI/0212-1(Mod. NIL)
13	Typical layout for 25kv Shunt capacitor with series reactor to be installed at 132/25kv TSS.	ETI/PSI/0223 (Mod. E)
14	Typical general arrangement of earth screen wire termination at Traction substation.	ETI/PSI/0225 (Mod. C)
15	Typical schematic diagram of protection for single transformer traction sub-station.	ETI/PSI/0228-1 (Mod-NIL)
16	High speed auto reclosing scheme for feeder circuit breaker at 25kV A.C TSS.	ETI/PSI/0231-I (Mod A)
17	Typical layout of 220/27kV traction substation (Type-I).	ETI/PSI/0240-1 (Mod.NIL)
18	Typical schematic diagram of protection for double Transformer traction substation.	ETI/PSI/024-1 (Mod. NIL)
19	Typical return current connection to buried rail at 220/25kV Traction sub-station.	ETI/PSI/0242 (Mod. A)

Sl. No.	TITLEOFDRAWINGS	DRAWINGNO.
20	Typical general arrangement of earth screen wire termination at 220/25kV traction sub-station.	ETI/PSI/0244
21	Typical earthing layout of a feeding station	ETI/PSI/203 (Mod. B)
22	Typical earthing arrangement for equipment/ structure at TSS.	ETI/PSI/228 (Mod-A)
23	Schematic inter connection diagram for remote control of power gear & supervision equipments at TSS.	ETI/PSI/644 (Mod. C)
24	Schematic inter connection diagram for remote control of power gear and supervision equipments at controlled station (SP & SSP).	ETI/PSI/645 (Mod. C)
25	General scheme of supply for25kV 50 Hz single phase AC traction system.	ETI/PSI/702-1 (Mod. D& E) &
26	Control desk arrangement for 2 work stations of SCADA system.	ETI/PSI/SK/337
27	Arrangement of suspension of double spider 25kV feeder and return feeder between substation and feeding station	RE/33/G/05152 (Mod. C)
28	Standard plan of control room at traction sub-station (General arrangement and RCC details)	RE/Civil/S-144/06
29	Typical schematic diagram for TSS, FP, SSP and SP with 21.6 MVA or 30 MVA transformers for three lines.	TI/DRG/PSI/3L-TSS/RDSO/00001/ 07/1 (Mod-NIL)
30	Typical layout of Control Room at traction sub-station.	TI/DRG/PSI/CPROOM/RDSO/ 00001/01/0
31	Typical layout of 132 /27kv Traction sub-station.	TI/DRG/PSI/TSSLO/RDSO/ 00001/01/0

Annexure – IX

DELETED

Annexure - X

List of Governing Acts, Regulations and Specifications

Indian Electricity Rules	1953 with latest amendments
Indian Electricity Act	2003
General Specifications for electrical works Part-1 internal (CPWD)	2005
IRSOD- (Revised) with updated correction slips	2004
EDFC SOD	2013
CBIP Manual	
TNEB Engineers hand book	
Westinghouse T & D book	
ITU-T Standards & guidelines for limits of interference with telecom circuits	
All BIS & IEC standards mentioned in the document or relevant/applicable to the subject	
Latest AC Traction Manual with updated correction slips	
All latest rules, regulations, guidelines and codes issued by statutory bodies and regulatory commissions pertaining to Electrical interface with utilities, interference to telecommunication circuits and other emission requirements.	

Annexure - XI

INTERFACE MATRIX-for Non-Traction Power Supply System

SN	Attributes	To be provided by Civil Contractor	To be provided by System Contractor
1	**11 kV Substation:**		
a)	Obtaining supply from SEB to 11kV/440 V substation of DFC through UG HT cable.	X	✓
b)	Provision of Change Over Switch, Bus Duct, Bus Coupler etc.	X	✓
c)	LT panel board/ Main distribution board complete with MCCB, protection, instrument meters, etc.	X	✓
d)	Earthing, Bonding and Lightning Protection System	X	✓
e)	Incoming and outgoing metering requirement for main/check meters for tariff purpose, Energy meters and meters for 3 phase outlets.	X	✓
f)	Anti climbing and Danger Notice plate	X	✓
g)	Connection from LT panel/ Main distribution board at 440 V Substation to LT panel/ SDB of various circuit and capacitor bank as per the concept plan.	X	✓
2	**Internal wiring in station building, service buildings, staff quarters, S&T installation within station building** (Appendix 3 (Design and construction interfaces) of Part 2: General Specification)	-	-
3	**Electrification/ Wiring of Station building/utility buildings/ S&T building /staff quarters:**		
a)	Main Distribution Board complete with MCB and RCCB	✓	X
b)	Internal wiring in open/ recessed conduit for lighting as well as power circuit with sub-distribution boards	✓	X
c)	Switch & Socket Outlets	✓	X
d)	Electrical indoor luminaries	✓	X
e)	Ceiling fans at all places	X	✓

f)	Provision of Window/Split Air Conditioner (Appendix 3 (Design and construction interfaces) of Part 2: General Specification)	X	✓
g)	Provision of Exhaust Fans	X	✓
h)	Provision of Water cooler	X	✓
i)	Provision of Ventilation requirement for S&T building including wiring	X	✓
j)	Provision of Fire Extinguisher & buckets as per NBC norms.	X	✓
4	**Street Lighting in colony with luminaries**	X	X
5	**Pumping Installation including wiring**	✓	X
6	**Provision of UPS/Inverter complete with Battery and battery charger at stations**	X	✓
7	**Outdoor Illumination for circulating area of station building**	X	√
8	**Emergency Circuit wiring within station building for essential load:**		
a)	Lighting	✓	X
b)	S&T equipment room in station building	✓	X
c)	Supply to Computers etc	✓	X
9	**Internal wiring for AT supply for emergency light & fan points**	✓	X
10	**SCADA system for Auxiliary Power supply**	X	✓
11	**25 kV/ 240V Auxiliary Transformer Stations for signalling/ telecommunications, Railway stations and level crossings and Line Side Cabins**	X	✓
12	**Electrification of RSS, TSS & Switching Posts**	X	✓
13	**Level Crossing (**Appendix 3 (Design and construction interfaces) of Part 2: General Specification)	-	-

Annexure- XII

List of Tentative Items for which Cross Acceptance criteria shall be applicable

S. No.	Items
1	Fault Locator
2	Motorised Isolator
3	Protection Panel and System
4	Resonance suppression CR device
5	Power Factor Correction System
6	Scott connected Transformer
7	Auto-Transformer
8	Numerical Protection Relay
9	Aerial Earth Wire
10	Feeder wire
11	220 kV Power Transformer

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Annexure-XIII

SPECIFICATION FOR 60/84/100 MVA, 220 kV or 132 /54 kV SCOTT-CONNECTED TRACTION POWER TRANSFORMER FOR 2x25 kV AT FEEDING SYSTEM

1 SCOPE

1.1 This document applies to 60/84/100 MVA, ONAN/ONAF/OFAF, 220 or 132 /54kV Scott-connected traction power transformers for Auto Transformer (AT) feeding system for installation in DFCC.

1.2 The transformer shall be complete with all parts, fittings and accessories whether specifically mentioned herein or not, necessary for its efficient operation in an unattended traction substation And it shall be supplied with appropriate firefighting system as per IS-3034:1993 or with Nitrogen Injection Fire protection system as per safety guidelines 2010 issued by CEA.

2 GOVERNING SPECIFICATION

2.1 In the preparation of this document, assistance has been taken from the following National and International standards, wherever applicable.

Table No. 2.1.1

Standard		Description
Equivalents	**IS**	
IEC 60076 (all parts)	IS:2026 (all parts)	Power transformers.
IEC 60044-1	IS:2705	Instrument transformer – Part 1: Current transformer.
IEC 60137	IS:2099	Bushing for alternating voltages above 1000V
IEC 60214	IS:8468	Tap changers.
IEC 60296	IS:335	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear/ New insulating oils.
	IS:5	Colours for ready mix paints and Enamels.
IEC 60502-1	IS:1554 (Part 1)	PVC insulated (heavy duty) Electric cables: Part 1 For working voltages up to and including 1100V
	IS:1570	Schedules for Wrought Steels - Part 5: Stainless and heat resisting steels.
	IS:1576	Solid pressboard for electrical purposes
IEC 60422	IS:1866	Code of practice for electrical maintenance and supervision of mineral insulating oil in equipment
	IS:2927	Brazing alloy
JIS C 2553	IS:3024	Grain oriented electrical steel sheets and strips
	IS: 3637	Gas operated relays
	IS:3639	Fittings and accessories for power transformers
	IS:4253	Cork composition sheets : Part 2 Cork and Rubber
	IS:5561	Electrical power connectors

Standard		Description
Equivalents	**IS**	
IEC 60909	IS:13234	Guide for short circuit calculations in 3Phase ac systems.
IEC 60270	IS: 6209	High-voltage test techniques - Partial discharge measurements.
	IS:6600	Guide for loading of oil-immersed transformers
	IS:10028 (all parts)	Code of practice for selection, installation and maintenance of transformers
	IS:10593	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis
IEC 60137	IS: 12676	Oil impregnated paper insulated condensers bushings – dimensions and requirements
	DIN 7733	Laminated products, pressboard for electrical engineering, types.
		Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010, part-III, Sec.4, 2010 Rule no. 44 (2) (ix).

2.2 In case of any conflict between the contents of the above standards and this document, the later shall prevail.

3 CLIMATIC AND ATMOSPHERIC CONDITIONS

3.1 The transformer shall be suitable for outdoor use in moist tropical climate and in areas the limiting weather conditions which the equipment has to withstand in service are given in Clause 4.2 of Chapter- 4 of this Specification.

3.2 The transformer shall also be subjected to vibrations on account of trains running on nearby railway tracks.

3.3 The amplitude of these vibrations which occur with rapidly varying time periods in the range of 15 to 70 ms lies in the range of 30 to 150 microns at present, with instantaneous peaks going up to 350 microns. These vibrations may become more severe as the speeds and loads of trains increase in future.

4 TRACTION POWER SUPPLY SYSTEMS 2X25KV AT FEEDING SYSTEM

4.1 General Scheme

4.1.1 The electric power for railway traction is supplied in AC 50 Hz, single-phase through 2x25 kV AT feeding system, which has a feeding voltage (2x25 kV) from the traction substation (TSS) two times as high as the catenary voltage, which is 25 kV with respect to earth/rail. The power fed from the TSS through catenary and feeder wire is stepped down to the catenary voltage by means of autotransformers (ATs) installed about every 13 to 17 km along the track, and then fed to the locomotives. In other words, both the catenary and feeder voltage are, 25 kV with respect to the earth/rail, although the substation feeding voltage between catenary and feeder wires is 50 kV. The catenary voltage is therefore, the same as that in the conventional 25 kV system.

4.1.2 The power supply shall be obtained from the 220 kV / 132 kV, three-phase, effectively earthed transmission network of the State Power Utilities PGCIL / Indian Railwayat the TSS..

4.1.3 One outer terminal of the secondary windings of the traction transformer is connected to the catenary and the other outer terminal is connected to the feeder.

4.1.4 ATs shall be connected between 25 kV catenary and 25 kV negative feeder, with mid-point connected to rail and earth. Two adjacent AT's shall share power to feed trains at 25 kV/2x25kV system. The load current (current drawn by electric locomotives) from the TSS flows through the catenary and returns to the TSS through the negative feeder. For a train in an AT-cell (distance between two consecutive ATs), most of the current is fed to the electric locomotive by the ATs of that AT-cell. The Traction current returns in the rails/earth and is routed to the negative feeder through the neutral terminals of the autotransformers. The current in OHE, therefore, is an algebraic sum of 25 kV current feed to locomotives from AT and the 50 kV supply to ATs from the TSS.

4.1.5 Approximately midway between adjacent TSSs, a sectioning and paralleling post (SP) is provided. In order to prevent wrong phase coupling of power supply, a dead zone known as 'Neutral Section' is provided in the OHE opposite the TSS as well as SP. At the TSS, there are two-feeder circuit breakers for either side of the TSS for controlling the power fed to the OHE, in a single track section. Out of the two feeder circuit breakers one feeds both side of the OHE while the other remains (open) as standby. There is also a paralleling interrupter, which is normally closed, for either side of the TSS for paralleling the OHE. In case of fault in the OHE, the feeder circuit breaker of the TSS trips to isolate it. The Bridging Interrupter is used to feed one TSS up to the next TSS, in case the adjacent TSS is temporarily out of order.

4.1.6 For maintenance work and keeping the voltage drop within limit, one or more sub-sectioning and paralleling post (SSP) are provided between the TSS and SP. The supply control Posts are on an average located every 13-17 km interval. An SSP has four sectioning interrupters and one paralleling interrupter, whereas an SP has two bridging circuit breakers (which remain open under normal feeding condition) and two paralleling interrupters.

4.2 Protection System

4.2.1 The protection system of the traction transformer comprises the following:

1	Differential protection
2	Instantaneous and IDMT over-current, and earth fault protection on the primary side
3	Protection against phase-failure on the secondary side (i.e. to detect malfunction of feeder/transformer circuit breaker)
4	Buchholz Relay
5	Thermistor/Optical hot spot sensor. The Transformer should have built-in hot spot temperature devices to indicate and record the hot test spot temperature as per IEC-60076-2 (Ed. 3.0).
6	Temperature sensors for Transformer Oil. The Transformer should have built-in temperature devices to as per IEC-60076-2 (Ed. 3.0).

4.2.2 The protection systems for the OHE comprise the following:

1	Distance protection
2	Delta I type fault selective protection
3	Instantaneous over current protection
4	Under-voltage protection to avoid wrong phase coupling
5	Fault locating expert system based on AT voltage neutral current.

4.3 OHE General data

4.3.1 The OHE shall consists of (i) Contact wire of minimum 150 mm^2 cross section suspended directly from catenary wire of minimum 120 mm^2 cross section by a number of vertical dropper wires, usually at regular intervals and (ii) a feeder wire of stranded all aluminium conductor.

4.4 Traction Transformer General Data

4.4.1 The transformer shall have 60/84/100 MVA power rating based on ONAN/ ONAF/OFAF cooling. The transformer shall be supplied with ONAN rating only.

4.4.2 However, provision shall be made by the contractor for installing cooling fans for operation in ONAF mode (84 MVA), as & when required by the employer.

4.4.3 Further, provision shall also be made by the contractor for installation of oil pump for operation in OFAF mode (100 MVA), as & when required by the employer.

4.5 Nature of traction loads and faults on the OHE system

4.5.1 The traction load is a frequently and rapidly varying one; between no load and overload. The TSS equipment is subject to frequent earth faults/short circuits caused by failure of Insulation, snapping of OHE touching earth, wire dropped by bird connecting the OHE to earth/ over line structure, and miscreant activity. On an average, the number of faults/ short circuits per month could be as high as 40. The magnitude of the fault current may vary between 40% and 100% of the dead short circuit value. These faults are cleared by the feeder circuit breaker on operation of the distance, delta I and instantaneous over-current relays associated with the concerned feeder circuit breaker. In 2x25 kV system faults can occur with: feeder-earth; feeder-OHE and OHE-earth faults or a combination of them.

4.5.2 The existing Indian Railways ac electric locomotives are provided with silicon rectifiers fed dc motors or GTO/IGBT based power converter fed 3-phase Induction Motors and the average power factor generally varies between 0.7 and 0.85 lagging, without reactive power compensation, which introduces harmonic currents in the 25kV power supply system.

4.5.3 On DFCC (Eastern), Locomotives are proposed to have VVVF drives and improved power factor closer to 0.98 and negligible harmonics. The traction supply may therefore be at higher power factor than those on IR.

4.6 Short-Circuit Apparent Power of the system

4.6.1 The short-circuit apparent power at the transformer location for various system voltages is as under:

Highest system voltage (kV)	Short circuit apparent power (MVA)
72.5	3,500
123	6,000
145	10,000
245	20,000

4.7 Auxiliary power supplies at TSS

4.7.1 The following auxiliary power supplies are available

1	110V dc from a battery
2	240 V ac, 50 Hz, single-phase from a 25/0.24 kV auxiliary transformer fed from Traction supply.

5 RATING AND GENERAL DATA

5.1 The rating and general data of the transformer shall be as follows:

S.No.	Item	Description
1	Type	ONAN/ONAF/OFAF cooled, Scott-connected (3 phase/ 2 phase), step down power transformer, double limb wound,

S.No.	Item	Description
		core/shell-type for outdoor installation.
2	Windings	Primary windings shall be T-connected for three phase supply. Two secondary windings, one per phase, Main-phase (M-phase) and Teaser-phase (T-phase), with a phase difference of 90 degree. The primary and secondary windings shall be uniformly insulated.
3	Rated Frequency (Hz)	50 ± 3%
4	Rated 3-phase primary voltage between phases Un (kV)	220 or 132
5	Highest 3-phase system voltage between phases Um (kV)	245/145
6	Rated 2-phase secondary voltage (at no load), (kV)	54 per phase
7	Rated power, (MVA)	60/84/100 MVA ONAN/ONAF/OFAF (Each secondary winding shall have a rated power of 30/42/50MVA)
8	Rated current at the principal tapping: i. Rated primary current (A) Un 220 kV Un 132 kV ii. Rated secondary current (A)	 157.5 / 220.4 / 262.4 262.4 / 367.4 / 437.4 556 / 778 / 926 (for each secondary winding)
9	Percentage of impedance voltages, main/primary winding and teaser/primary winding at 30 MVA based at principal tapping.	%Z = 11-13%
10	Non-cumulative overload capacity on ONAN rating.	1) 150% rated load for 15 minutes 2) 200% rated load for 5 minutes
11	Polarity	Subtractive
12	Tapping (off - circuit)	Separate tapped winding on primary winding to give rated secondary voltage for variation in primary voltage of +10% to -15%, in steps of 5% each.
13	Temperature rise	1) Winding: 50K at rated load, and 60K for overloads as specified in Clause 5.1(10) (temperature measured by resistance method). 2) Top oil: 45K (temperature rise measured by thermometer). 3) Current carrying parts in air. 40K (temperature rise measured by thermometer).
14	Maximum permissible losses at principal tap	
	1.No-load losses ,kW as per IEC 60076-1 clause 3.6.1	55 kW
	2. Total load losses at the principal tapping including core, windings, frame parts, tank and auxiliary requirements as	275 kW at 60 MVA ONAN

S.No.	Item	Description		
	per IEC 60076-1 clause 3.6.3			
	3. Total Losses as per IEC 60076-1 clause 3.6.4	320 kW		
15	Ability to withstand short circuit: 1.Thermal ability 2.Dynamic ability	2s 0.5s		
16	Flux density at rated voltage and frequency at principal tapping.	Shall not exceed either 1.7 T.		
17	Current density in the windings.	Shall not exceed 2.5A/mm^2 at 60MVA for ONAN.		
18	Acoustic sound level when energized at rated voltage and at no-load.	NEMA R-1-1993 (R2000) Table -2.		
19	Bushing	(i) Item	(ii) Secondary	Primary (220/ 132 kV)
		(iii) Type	OIP condenser	OIP condenser
		Highest voltage for equipment Um(kV)	54	245/145
		Rated current(A)	1250	800
		Minimum Creepage distance in air (mm)	1300	6125/3625
20	Bushing type current transformers for differential protection of transformer	Item	Secondary	Primary
		Highest voltage	52	245/145
		CT Ratio	1000/5	300/5, 600/5
		Frequency(Hz)	50 +/- 3%	50 +/- 3%
		Class of accuracy as per IEC60044-1.	PX	PX
		Minimum knee-point emf,(V)	150	125/175
		Maximum excitation current at knee-point voltage (A)	0.25	0.75
		Maximum resistance of the secondary winding, (Ω)	0.5	0.25

6 SALIENT DESIGN FEATURES

6.1 Overall dimensions

6.1.1 The overall dimensions of the transformer shall be kept as low as possible and in any case shall not exceed the transportation limit in India.

(Transportation dimension)

1	Length x Width (in mm)	14,000 x 6,500
2	Height of topmost point of primary bushing terminal	7,500 mm
3	Height of topmost point of secondary bushing terminal	5,500mm

6.1.2 The manufacturer shall, where practical, design the transformer so that with the bushings &

accessories removed, the transformer shall fit within Indian Railway loading gauge, in case it is transported through rail, MMD to be enclosed with the offer.

6.1.3 The transformer should be designed nitrogen or dry air filled such that it can be transported without the Insulation oil inside the tank. The transformer shall be designed such that it can be transported with tank under pressure with nitrogen and other protective measures that the Manufacturer recommends, so that no moisture can enters the housing.

6.2 Tank

6.2.1 The tank for the transformer shall be of the top cover jointed with bolted connection. The bottom plate of main tank shall be firmly welded to the main body and the top cover is a plate reinforced with ribs. The winding and core shall fully exposed when the tank cover is lifted. A pressure gauge along with a hygrometer shall be provided so that the status of dryness of the winding can be assessed in the transformer prior to its heat run before commissioning.

6.2.2 The tank shall be constructed from mild steel of a quality that allows welding without any defect/flaw, with a single tier construction, shaped so as to reduce welding to the minimum. The welded joints shall be made using good engineering practices. The tank shall be adequately strengthened for general rigidity to permit hoisting of the transformer filled with oil by crane. The tank body shall be designed to withstand against the full vacuum degree.

6.2.3 The tank shall be fitted with four lifting pads at the lower end to enable lifting of the transformer filled with oil by means of lifting jacks.

6.2.4 The tank shall be fitted with an under carriage and mounted on bidirectional swiveling type flanged rollers for being rolled on 1676mm (5' 6") gauge track, on which it shall also rest in the final position. The rollers shall be provided with detachable type locking arrangement to enable their locking after installing the transformer in the final position, to hold the transformer fixed on foundation and to prevent any accidental movement of the transformer.

6.2.5 There shall be at least five inspection covers of suitable size on the tank to enable inspection of the lower portions of bushings, and the leads as well as the various connections of the motorised off-circuit tap-changer.

6.2.6 The gaskets with groove NBR (NITRILE BUTADIENE RUBBER) shall be provided for oil sealing points. The rubberized cork gasket may be used for other general portion.

6.2.7 All valves used in the transformer shall be capable to withstand full vacuum degree. The manufacturer shall ensure that suitable anti-theft measures like locked use of blanking plates are provided on these valves, so as to prevent pilferage/theft of oil during transit and service.

6.3 Marshalling box

6.3.1 A vermin proof, weatherproof and well ventilated, marshalling box with IP class 55, made up of sheet steel of thickness not less than 2 mm, strengthened with adequate stiffeners, shall be provided on the left hand side of the transformer tank as viewed from the secondary terminals side. It shall have a hinged door, with provision for padlocking the door opening outward horizontally.

6.3.2 The marshalling box shall have a sloping roof. The top of the marshalling, box shall be at a height of about 2 m from the transformer rail level.

6.3.3 The marshalling box, shall house the winding and oil temperature indicators and terminal board. To prevent condensation of moisture in the marshalling box, metal clad space heater controlled by an associated thermostat and switch shall be provided. Cable glands shall be provided for the incoming and outgoing cables.

6.3.4 The temperature indicators shall be so mounted such that their dials are at a height of not more than 1.6 m from the rail level. Transparent windows of tough acrylic plastic or similar non-fragile

transparent material shall be, provided on the marshalling box, so as to enable reading of the temperature indicators without opening the door of the marshalling box

6.3.5 All cables from the bushing current transformers, Buchholz relay, magnetic oil level gauge, pressure relief device and, temperature indicators shall be run up to the marshalling box. The cables shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armored, stranded copper conductor conforming to IEC 60502-1. The cables shall, be adequately insulated for heat from the tank surface and the sun.

6.3.6 All wiring in the marshalling box shall be clearly identified by lettered/figured ferrules of the interlock type, preferably of yellow colour with-black letters/figures. The ac and dc circuits shall be clearly distinguished and well separated from each other.

6.3.7 Suitable legend and schematic diagram plates made of anodized aluminium with black lettering and lines shall be fixed on the inside surface of the marshalling box door.

6.4 Core

6.4.1 The core shall be built-up of high permeability cold rolled grain oriented silicon steel laminations conforming to JIS C2553 or equivalent IS as indicated in Table No. 2.1-1. The flux density in any part of the core and yokes at the principal tapping with primary winding excited at the rated primary voltage and frequency shall not exceed 1.7 T. The successful bidder / manufacturer shall furnish calculations to prove that this value shall not be exceeded.

6.4.2 The lamination for the core shall be free from waves, deformations and signs of rust. Both sides of the laminations shall be coated with suitable Insulation capable of withstanding stress relief annealing. In assembling the core, air gaps shall be avoided. Necessary cooling ducts shall be provided in the core and yoke for heat dissipation. The core clamping frame shall be provided with lifting eyes for the purpose of tanking and un-tanking the core and winding of the transformer.

6.4.3 The core shall be electrically solidly connected to the tank.

6.4.4 Design of the Core shall be boltless and it shall be tightened by binding the laminations using resin glass tape. Core laminations shall be tested after completion of the core assembly to ensure that they withstand a voltage of 2 kV r.m.s with respect to core for duration of 60 seconds.

6.4.5 The transformer is required to be continuously in service, preferably without requiring any attention from the date of its energisation up to the periodical overhaul (POH), which is generally done after 10-12 years of service. The successful bidder/ manufacturer of the transformer shall, take this aspect into account during core assembly/manufacture and indicate measures taken by them to ensure suitable clamping to permit the above frequency and cover this in their instruction manual.

6.5 Windings

6.5.1 The winding shall be of disc/interleaved/inter-shield/rectangular pancake type for the primary and of disc/helical/cylindrical/rectangular pancake type for the secondary windings. The primary and secondary windings shall be uniformly insulated. All the four terminals of both secondary windings of 'M' and 'T' phases shall be brought out separately through 54 kV OIP condenser bushings, for cascade connection externally. The QAP of the manufacturing process is to be submitted along with the bid.

6.5.2 The workmanship shall be of high quality in keeping with Good Engineering Practices and as for Insulation, insulating materials of class A or higher should only be used.

6.5.3 No joint shall be used in the winding conductor, in principle, except for inter-leave joint.

6.5.4 Separate tapped coil shall be provided for each primary winding for connection of the

motorized off-circuit tap-changer. The tapped coils shall be distributed in multi-sections in order to reduce the imbalance in ampere turns to the minimum at any tap position.

6.5.5 Separate tapped winding shall be provided for each primary winding. The transformer windings shall be designed for the following rated withstand voltages:

	Item	Secondary	Primary (220/ 132 kV)
1	Highest voltage for equipment Um(kV)	52	245/145
2	Rated short duration power frequency withstand voltage (kV)	95	395/275
3	Rated lightning impulse withstand voltage (kV peak)	250	950/650

6.5.6 The windings shall be so designed that the transfer of lightning and switching surges from primary to secondary windings and vice-versa is kept to the minimum level.

6.5.7 The axial pre-compression on the windings shall not be less than the double the calculated axial thrust that may be set up under dead short-circuit condition so; as to ensure that the windings do not become loose due to frequent short circuits in service.

6.5.8 During short circuits, the stresses set up in conductors, spacers, end blocks, clamping, rings and such other parts of the transformer; shall not exceed one third of the maximum permissible values.

6.5.9 Pre-compressed spacers shall be used between disc shaped coils of the windings to transmit the axial forces generated due to the short circuits.

6.5.10 A uniform shrinkage shall be ensured during the drying of the individual coils or assembly of coils by providing a uniform clamping force with the help of hydraulic jacks or similar devices.

6.5.11 In order to keep unbalanced axial force due to non-uniform shrinkage/unequal height of the coils to the minimum, wedges of pre-compressed wood or similar such material shall be used.

6.5.12 The successful bidder/ manufacturer shall ensure that there is no further shrinkage of the coil assembly in any additional cycle after the final curing.

6.5.13 The separate winding compression structure suitable shall be provided apart from the core clamping structure in order to not causing any loose. The equal axial force compression system shall be applied on to each assembled windings throughout the drying process and fixing with the high tension self-tightening structure to eliminate any loose unbalanced face due to non-uniform shrinkage of windings. To prevent displacement of the radial spacers used in the windings, closed slots shall be provided.

6.5.14 The vertical locking strips and slots of the radial spacers shall be so designed as to withstand the-forces generated due to short circuits.

6.5.15 The vertical locking strips and radial spacers shall be made of pre-compressed pressboard conforming to grade PSP: 3052 of DIN 7733.

6.5.16 To prevent end blocks from shifting, pre-compressed pressboard ring shall be provided in between the two adjacent blocks. Coil clamping rings made of densified wood or mild steel shall be located in position with pressure screws.

6.5.17 Leads from the windings to the terminals, from the tap switch to the tappings of the primary windings and other interconnections shall be properly supported and secured.

6.5.18 The following particulars/ documents in respect of the radial spacer blocks (winding blocks), vertical locking strips (axial ribs), end blocks, insulating cylinder, angle rings, paper Insulation of the conductor and coil clamping plates used in the manufacture of the windings shall be

furnished.

i. Reference to specification-and grade of material.

ii. Source(s) of supply,

iii. Test certificates.

7 INSULATING OIL

7.1 The transformer shall be supplied with new inhibited mineral insulating oil conforming to IEC 60296. In addition, 10% extra oil by volume, shall be supplied in nonreturnable steel drums. The characteristics of the insulating oil before energisation of service shall conform to IEC 60296.

8 BUSHINGS AND TERMINAL CONNECTORS

8.1 Both the primary and secondary side bushings shall conform to IEC 60137. On the primary, side, sealed draw lead type Oil Impregnated Paper (OIP) condenser bushings shall be used. On the secondary side, sealed solid stem type OIP condenser bushings shall be used.

8.2 The bushings shall have a non-breathing oil expansion chamber. The expansion chamber shall be provided with an oil level indicator, which shall be so designed and dimensioned that oil level is clearly visible from ground level.

8.3 A test tap shall be provided for dielectric or power factor measurement.

8.4 The bushings shall be designed for the following Insulation level:

1	Highest voltage for equipment Um (kV)	52	245/145
2	Rated short duration wet power frequency withstand voltage (kV)	95	460/275
3	Rated lightning impulse withstand voltage (kV peak)	250	1050/650

8.5 Adjustable arcing horns shall be provided on both the primary and secondary bushings. The horn gap setting shall be variable as indicated below:

1.	Highest voltage for equipment Um, kV	52	245/145
2.	Horn gap setting variable between, mm	150 and 300	1200 and 1500 500 and 900

8.6 The design and construction of the bushing shall be such that stresses due to expansion and contraction in any part of the bushings shall not lead to its deterioration breakage. The bushings shall be free from corona and shall not cause radio interference.

8.7 The bushing terminals shall be provided with terminal connectors of bimetallic type and shall be such that there is no hot spot formation even during the extreme over load condition of ONAN rating with 200% over loading.

8.8 The terminal connectors shall conform to IS: 5561. The design shall be such as to be connected to the equipment terminal stud with a minimum of four 12 mm diameter bolts, nuts, spring and flat washers.

9 BUSHING TYPE CURRENT TRANSFORMERS

9.1 The 52 kV and 245/145 kV bushings shall be so arranged as to accommodate bushing type current transformers (BCTs) for the biased differential protection of the transformer. The BCTs

shall conform to IEC 60044-1 and meet with the stipulations in Clause 5.1(20) of this document.

9.2 The BCTs shall be so designed as to withstand thermal and mechanical stresses resulting from frequent short circuits experienced by the transformer on which these are fitted.

9.3 Apart from the BCTs required for the biased differential protection, BCT of accuracy class 5 and conforming to IEC 60044-1, with suitable tappings, shall be mounted inside one bushing of the left-hand side (as viewed, from the. secondary; terminals, side) of each secondary winding 'M' and 'T' phases for use with the-winding temperature indicators.

9.4 The BCTs and the bushings shall be so mounted so that removal of a bushing can be achieved without disturbing the current transformers, terminals and connections or pipe work is easy and convenient.

9.5 The leads from the BCTs shall be terminated in terminal boxes provided on the bushing turrets. Suitable links shall be provided in the terminal boxes for shorting the secondary terminals of the BCTs, when not connected to the external measuring circuits.

9.6 The leads from the secondary winding of the BCT terminated in the terminal box on the bushing turret up to the marshalling box shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armoured, stranded copper cable of cross section not less than 4 mm^2 to IEC 60502-1.

9.7 Cable glands of proper size shall be provided in the terminal boxes to lead in/lead out the cables.

10 CLEARANCES

10.1 The relative orientation in space of the bushings fitted with terminal connectors the main tank, radiators, conservator, pressure relief device, oil piping and other parts when mounted on the transformer shall be such that the various clearances in air from bushing live parts shall not be less than the appropriate values given here under:

1	Highest voltage for equipment Um(kV)	52	245/145
2	Minimum clearance (mm)	500	1900/1200

The same distance shall apply for clearances phase-to-earth (including oil piping work, conservator, pressure relief device and such other parts), phase-to-phase and towards terminals of a lower voltage winding.

11 MOTORISED OFF-LOAD TAP-CHANGER

11.1 The transformer shall be fitted with a motor operated off-circuit rotary type tap-changer, to cater for the voltage, range specified in Clause 5.1(12) of this document. Visibility of the tap position should be such that display is legible. The motor drive unit shall be installed in a weather and corrosion proof adequately ventilated cubicle made of sheet steel not less than 2 mm thick with adequate stiffeners to prevent deformation during transit and handling. The cubicle shall have a sloping roof. The top of the cubicle shall be at a height of about 1.5 m from the rail level. The cubicle shall be so positioned that the hinge of the operating handle for manual operation is at a height of about 1.1 m from the rail level.

11.2 To prevent condensation of moisture in the cubicle, metal clad space heater, controlled by an associated thermostat and switch, shall be provided.

11.3 All wiring in the cubicle shall be clearly identified by lettered/figured ferrules of the interlock type, preferable of yellow colour with black letters/figures. The ac and dc circuits shall be

clearly distinguished and well separated from each other.

11.4 Suitable legend and schematic diagram plates made of anodized aluminium with black lettering and lines shall be fixed on the inside surface of the cubicle door.

11.5 A tap position indicator shall be provided to indicate the tap position which shall be clearly visible to an operator standing on the ground.

11.6 The tap-changer motor shall be suitable for operation off 110 V from a battery. The voltage at the battery terminals may vary between 110% and 85% of the normal value. The voltage at the tap-changer motor terminals is likely to be less than 85% of the normal value of 110 V due to voltage drop in control cable.

11.7 The circuit for the tap changer motor shall be such that the roller does not get stuck between the two taps, should the 110 VDC supply to the motor fails.

11.8 The tap-changer shall be provided with suitable interlocking arrangement to prevent its operation (including manual tap changing) when either one or both circuit breakers on the primary as well as on the secondary sides of the transformer is/are in closed condition.

11.9 The tap-changer and its control circuit shall be designed for operation from the Remote Control Centre (RCC) by the Traction Power Controller (TPC) as well as from the tap-changer cubicle. A local/remote switch as well as necessary terminations for tele-signals and tele-commands from and to the tap-changer-for-operation from the RCC-shall therefore be provided in the tap-changer cubicle.

12 COOLING EQUIPMENT

12.1 The transformer shall be designed to be ONAN/ONAF/OFAF Cooled. The transformer shall be designed such that in case of emergency feed extension, it shall be capable of delivering 40% more of the ONAN rating based on the installation and commissioning of forced cooling and 100 MVA when oil pumps are further installed in future.

12.2 The fans shall be designed with 50% redundancy.

12.3 The fans shall be fitted with fan failure alarms. These alarms shall be routed back to the marshalling box, for connection to the SCADA system. There shall be visual indication in the marshalling box as to which fan group has failed.

12.4 The radiators shall consist of a pressed steel plate assembly formed into elliptical oil channels as per IEEMA Standard. The radiators shall be designed in such a manner that the temperature-rise limits specified under Clause 5.1 (13) of this document are not exceeded.

12.5 The radiators shall be removable (after isolating the same from the main tank) to facilitate transportation of the transformer. A drain plug of size 19 mm and an air-release plug of size 19 mm shall be provided at the bottom and at the top of each radiator bank for draining and filling of oil respectively. Each radiator bank shall also be provided with shut-off valves. If radiators are supplied as a separate unit, then body bellows type flexible joints shall be provided on the oil headers.

12.6 The radiators shall preferable be supported directly on the transformer tank. Each radiator bank shall be fitted with lifting lugs.

13 PARTS, FITTINGS AND ACCESSORIES

13.1 Apart from the parts, fittings and accessories specifically detailed in the foregoing Clauses, the parts, fittings and accessories detailed hereunder shall be supplied with each transformer.

13.1.1 **Conservator Tank**: It shall be of adequate capacity and complete with supporting bracket or

structure, oil filling cap and drain valve of size 25 mm. The cylindrical portion of the conservator tank shall be of single piece construction without any gasket joint. Suitable air cell/ separator arrangement of high quality material shall be provided in the conservator to ensure that the transformer insulating oil does not come in contact with air. The material of cell / separator shall be coated fabric consisting of highly resistant polyamide fabric, externally coated with perfectly transformer oil resisting coating (Chemical), inner coating resisting ozone & weathering. Suitable instructions may be provided for installation/ commissioning & maintenance of air cell / separator arrangement.

13.1.2 **Oil Level Gauge**: It shall be of magnetic type having a dial diameter of 200 to 250 mm. The gauge shall have markings corresponding to minimum oil level, maximum oil level and oil level corresponding to oil temperature of 30^{o}C, 45^{o}C and 85^{o}C. The oil level indicator shall be so designed and mounted that the oil level is clearly visible to an operator standing on the ground. The oil level gauge shall be fitted with two SCADA readable contacts. The first contact shall provide a warning that the oil level is at 25% above the minimum level. The second contact shall indicate when the minimum oil level has been reached.

13.1.3 **Silica Gel Breather**: It shall be complete with oil seal and connecting pipes. The connecting pipes shall be secured properly. The container of the silica gel breather shall be of transparent flexi glass or similar material suitable for outdoor application.

13.1.3.1. Orange silica gel (round balls 2 to 5 mm) with quantity of two DT-8 silica gel connecting with flanged mounting two pipes control through different valves as per DIN: 42567 & IS: 6401 to be provided.

13.1.4 **Pressure Relief Device**: Shroud Pressure Relief Device will be used and have provision of discharge of oil from PRD to safe place by closed pipeline. This avoids hazards of fire and it is safe to persons working near Transformer & it is environment friendly. It shall be designed to operate to release internal pressure at preset value without endangering the equipment or operator & shall be of instantaneous reset type.

13.1.5 **Filter Valves**: The bottom and upper filter valves shall be of 50 mm size and suitably baffled to reduce aeration of oil. The valves shall be flanged to seat 40 mm adopter threaded to thread size P 1-1/2 for connection to oil filtration plant.

13.1.6 **Drain Valve**: It shall be of size 80 mm fitted with an oil sampling device of size 15mm.

13.1.7 **Earthing Terminals**: Two earthing terminals of adequate size shall be provided on the tank for its earthing with the help of 3 mild steel flats, each of size 75 mm x 8 mm. The terminals shall be clearly marked for earthing.

13.1.8 **Buchholz Relay**: It shall be of double float type, with two shut-off valves of 80 mm size, one between the conservator tank and the Buchholz relay and the other/between the transformer tank and the Buchholz relay. The relay shall have one alarm contact and one trip contact, none of the contacts being earthed. The contacts shall be of mercury/micro switch type, electrically independent and wired up to the marshalling box. A testing petcock shall be brought down through a pipe for the purpose of sampling the gas, if any, collected in the Buchholz relay.

13.1.9 **Oil temperature indicator (OTI)**: It shall have one alarm contact, one trip contact and two normally open spare contacts none of the contacts being earthed. The contacts shall be electrically independent.

13.1.10 **Winding temperature indicator (WTI)**: Two WTIs shall be provided, one for the M-phase and the other for the T-phase. Each WTI shall have one alarm contact, one trip contact and two normally open spare contacts, none of the contacts being earthed. The contacts shall be electrically independent.

The windings shall also be fitted with analogue temperature sensors/thermistors/optical sensors that are suitable for being remote read via the SCADA system.

13.1.11 **Thermometer Pockets**: A separate thermometer pocket with cap shall .be provided on the tank for measuring the top oil temperature in the tank. The thermometer shall indicate hot spot temperature.

13.1.12 **Rating Plate**: The rating plate shall indicate the following:

- The ratings of the transformer
- The connection diagram of the windings
- The particulars of the bushing current transformers
- Weight without oil
- Weight with oil
- Kind of transformer (I.e. Scott Connected traction transformer)
- Manufacturer
- Date of manufacture
- Serial number
- Rated Voltages in (kV) and tapping range
- Rated primary and secondary currents
- Short circuit impedance
- Type of cooling
- Other details as per IEC 60076-1.

The rating plate shall be both in English and Hindi version.

13.2 All valves shall be of the double flange type and fitted with suitable blanking plates on the outer face of the exposed flange.

13.3 The capillary tubes for temperature indicators shall be able to withstand normal bending. They shall be supported properly without sharp or repeated bends or twists.

13.4 **Fibre Optic Hot Winding Temperature Monitor**

Fibre optical winding hot spot temperature monitor to be provided with the transformer windings, connected in addition to the winding temperature indicator in parallel to measure transformer winding hot spots in real time and activate control of the cooling system. The fibre to be given high strength casing through rugged jacketing and fibre to be securely routed till the tank wall plate. The application of fibre optic shall be governed by IEC-60076-2 (Ed. 3.0).

Specification for Fibre Optic Temperature Measurement System

Fiber optic based temperature measurement of Oil and windings shall be done using Fiber Optic Sensors meetings following broad criteria:

13.4.1 System shall be of proven technology. The temperature sensing tip of the fiber optic shall be ruggedized. The probes shall be directly installed in each winding of power transformer to measure the winding hot spot and at the top oil temperature. There shall be at least 4 probes inside the transformer.

13.4.2 Out of the 4 probes one probe shall be used for top oil temperature measurement, one fort winding and balance two for LV windings.

13.4.3 Probes shall be able to be completely immersed in hot transformer oil. They shall withstand exposure to hot vapour during the transformer Insulation drying process, as part of Vacuum Phase Drying (VPD). The probes shall meet the requirement to eliminate the possibility of

partial discharge in high electric stress areas in the transformer. Probes shall preferably have certified Weidman testing for electrical parameters as per ASTM D-3426 and ASTM D-149 that is current (no more than 1 year old). Test results and studies to be submitted by the transformer manufacturer along with the first unit of a certain type of traction power transformer.

13.4.4 Temperature range of the system should be up to +200°C without any need of recalibration. Probes must connect to the tank wall plate with threaded connectors containing a Viton O-ring to prevent against oil leakage.

13.4.5 Probes shall be of material inert to mineral and ester oils, multiple jacketed (Kevlar preferred), perforated out jacket to allow complete oil filling and mechanical strength.

13.4.6 System should include analog outputs for each measurement channel. Temperature resolution of the analog outputs shall be ±0.1°C and precision of ±0.5°C and the system shall offer user programmable temperature alarm outputs with 8 relays. The cooling system (Fans & Pumps) should be operated through these relays. The temperature settings for the relays shall be made as per the end-user request.

13.4.7 All inputs and outputs of the system shall meet the requirements of surge test of IEEE C37.90.1-2002. The system should electronically store testing records of components and allow for on board diagnostics and instructions, including a signal strength reading to verify integrity of fiber optic connections. System should contain a battery for date/time stamp of data readings. The system should comply with IEC61850 protocol, along with DNP 3.0, Modbus, TCP/IP and ASCII.

13.4.8 The transformer manufacturer should submit details showing that the probes are located in the hottest point of the winding, while submitting Drawings for approval. The manufacturer are free to use more than 4 probes if design so required.

13.4.9 The controller shall be housed in cooler cubicle or in a separate enclosure having ingress protection IP 56.

13.4.10 Temperature Rise Test Measurements shall be made with the Fiber Optic Thermometers.

The equipment shall be operational during temperature tests and be demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified and temperature data for all probes recorded and reported in the test report.

13.5 The manufacturers of Part, Fittings & Accessories for the transformer shall be mentioned in the SOGP/BOM & got approved. During prototype test, the accessories will be tested & performance monitored by either at Customer Hold Point (CHP) or by Test Certificate (TC) Verification.

In case manufacturers desire to change a particular make of accessory, prior approval of Engineer shall be required and SOGP as well as Bill of Material (BOM) shall have to be got approved from Engineer.

In case of make of accessories approved under Customer Hold Point (CHP) for regular production, the Engineer's approval shall be required separately on SOGP and BOM. The Traction Power Transformer manufacturer shall be responsible for availability of compatible accessories for the equipment approved.

14 FASTENERS

14.1 All fasteners of 12 mm diameter and less exposed, to atmosphere shall be of stainless steel and those above 12 mm diameter shall preferably be of stainless steel or of, mild steel hot dip galvanized to 610g/m of zinc. The material of the stainless steel fasteners shall conform to IS: 1570 (Part-V), Grade 04Cr17Ni12Mo2 or equivalents

15 PAINTING

15.1 Shot blasting/ sand blasting shall be done on the transformer tank to remove all scales rust and other residue, before applying the paint inside the tank. All steel surfaces which are in contact with insulating oil shall be painted with heat resistant oil-insoluble insulating varnish. All steel surfaces exposed to weather shall be given, one primer coat of zinc chromate and two coats of anti-corrosion grey paint. The touch-up of gray paint shall be applied at site by, the manufacturer.

16 TESTING OF TRANSFORMER

16.1 **General**

16.1.1 The designs and Drawings of transformer together with detailed calculations & the Quality Assurance Plan (QAP) shall be furnished to the Engineer, within the period stipulated in the contract. Only after all the designs and Drawings as well as the QAP have been-approved for prototype tests and a written advice given to that effect, shall the successful bidder/manufacturer take up manufacture of the prototype of the transformer. It is to be clearly understood that any change or modification required by the above authorities to be done in the prototype shall be done expeditiously, notwithstanding approval having already been given for the, designs and Drawings. Such change or modification shall be incorporated in the Drawings.

16.1.2 Prior to giving a call to the Engineer for inspection and testing of the prototype, the successful bidder/manufacturer shall submit a detailed test, schedule consisting of schematic circuit diagrams, for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. In case any dispute or disagreement arises between the successful bidder/manufacturer and representative of the Engineer during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the Engineer, as the case may be, whose decision shall be final and binding. Only after the prototype transformer is completed and ready in each and every respect, shall the successful bidder/manufacturer give the actual call for the inspection and testing.

16.1.3 The type tests shall be carried out on the prototype transformer at the works of the successful bidder/manufacturer or at reputed testing laboratory in the presence of the representative of the Engineer, in accordance with the relevant specifications and as modified or amplified by this document.

16.2 **Tests during manufacture**

16.2.1 Though the tests described below shall form part of the type tests, the manufacturer shall carry out these tests on each unit during the process of manufacture and submit the test reports to the Engineer deputed for witnessing the routine tests:

- Oil leakage test.
- Vacuum test.
- Pressure test.
- Test for pressure relief device.
- Measurement of capacitance and tan-delta values.

16.2.2 **Oil Leakage Test**: The transformer with its radiators, conservator tank and other parts, fittings and accessories completely, assembled shall be tested for oil leakage by being filled with oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure corresponding to twice the normal static oil head or to the normal static oil head plus 35 kN/m^2

(0.35 kgf/cm^2) whichever is lower, the static oil head being measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hr., during which time no leakage shall occur.

16.2.3 **Vacuum Test**: The transformer tank only shall be tested at a vacuum of 3.33 kN/m^2 (0.0333 kgf/cm^2) for 60 min. The permanent deflection of flat plates after release of vacuum shall not exceed the values specified below:

Horizontal length of flat plate	Permanent deflection (mm)
Up to and including 750mm	5.0
751mm to 1250mm	6.5
1251mm to 1750mm	8.0
1751mm to 2000mm	9.5
2001mm to 2250mm	11.0
2251mm to 2500mm	12.5
2501mm to 3000mm	16.0
Above 3000mm	19.0

16.2.4 **Pressure Test**: Every transformer tank, radiator and conservator tank shall be subjected to an air pressure corresponding to twice the normal static head of oil or to normal static oil head pressure plus 35 kN/m^2 (0.35 kgf/cm^2) whichever is lower as measured at the base of the tank. The pressure shall remain constant for 1 hour to indicate that there is no leakage.

16.2.5 **Test of Pressure Relief Device**: Every pressure relief device shall be subjected to gradually increasing oil pressure. It shall operate before the pressure reaches the test pressure specified in Clause 16.2.4 hereof and the value; at which it has operated shall be recorded.

16.2.6 **Measurement of capacitance and Tan-Delta values**: The measurement of capacitance and tan-delta (dielectric loss factor) of the transformer windings shall be made by Schering Bridge.

16.3 **Type Tests**

16.3.1 General

The type tests shall be carried out on' the prototype transformer at the works of the successful bidder/manufacturer or at any reputed laboratory in the presence of the representative of the Engineer and in accordance with the relevant specifications and as altered, amended or supplemented by this document. Amongst others, the following shall constitute the type tests:

i. Temperature-rise test

ii. Lightning impulse test.

iii. Test with lightning impulse stopped on the tail

iv. Short circuit test.

v. Measurement of acoustic sound level.

vi. Measurement of partial discharge quantity.

vii. Measurement of harmonics of no-load current.

16.3.2 Temperature-rise test:

16.3.2.1 The temperature rise test shall be done with the tap changer on the lowest tap position (-15%). in accordance with IEC60076-2 except as modified hereunder.

1	At rated load at ONAN, ONAF, OFAF rating.
2	At 150% rated load for 15min after continuous operation at rated load for 1hr. at ONAN rating
3	At 200% rated load for 5 minutes after continuous operation at rated load for one

	hour at ONAN rating.

The tests shall be done continuously without any power supply interruption. In case interruptions of power supply do take place for some reason, then the entire test shall: be repeated after steady state conditions are attained.

16.3.2.2 The points to be ensured during the temperature rise test shall be:

1	The ambient temperature shall be measured using calibrated thermometers only
2	The winding temperature shall be determined by the resistance method only.
3	The temperature of the top oil shall be measured calibrated thermometer placed in an oil-filled thermometer pocket.
4	The average oil temperature shall be calculated as the difference between the top oil temperature and half the temperature drop in the cooling equipment (radiators)
5	The temperature of the hot-spot in the winding shall be the sum of the temperature of the top oil and 'H' times the temperature rise of the winding above the average oil temperature, where 'H' is the hot spot factor as per IEC 600076-2 and 60076-7.

16.3.2.3 The test shall be carried out as described below:

16.3.2.3.1 **100% load**

1	A quantum of power equal to the sum of the measured losses viz. no-load and load losses measured at minus 15% tap position,/corrected to 75^0C plus 10% of such sum shall be fed to the primary winding of the, transformer with the secondary windings short-circuited.
2	The power so fed to the transformer shall be continuously maintained till such time as the steady stats temperature is reached i.e. the top oil temperature rise does not vary by more than 1^0C during four consecutive hourly readings
3	On attaining the steady state temperature, the current in the primary winding of the transformer shall be brought to the rated current which shall-be maintained for one hour. At the end of the period the power supply to the transformer shall be switched of and the time of Switching off recorded
4	The measurement of resistance shall commence as soon as is possible after switching off. The first reading of the resistance shall be taken as soon as possible, before the expiry of 90 seconds from the instant of switching off and the first ten readings shall be taken at intervals of l5s apart. Thereafter, another ten readings shall be taken at intervals of 30s apart.
5	The time at which each of the resistance values is read shall also be recorded.
6	The temperatures of the ambient, top oil, the top and bottom radiator header oils shall also be recorded at half-hourly intervals throughout the test starting from the instant power supply is; switched on to commence the if test till it is switched off.
7	The WTI and OTI readings shall also be recorded at half hourly intervals right from the instant the power supply is switched on to commence the test till it is switched off
8	After power supply is switched off the readings of OTI and WTI shall be recorded at intervals of 1 min apart for 30 min

16.3.2.3.2 **150% load**

1	After completion, of the test at 100% load, the transformer shall be fed with power which shall be a value so as to cause circulation of the rated current in the primary, winding with secondary windings short circuited. This current shall be circulated for 1h.
2	The current shall thereafter be increased to 150% of the rated current and maintained-for a" period of 15min. At the end of the 15 min period the power

	supply shall be switched off and the time of switching off recorded.
3	Thereafter the readings as indicated in Clause 16.3.2.3.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top oil, the top and bottom radiator header oil and the temperatures indicated by OTI and WTI shall also be recorded at the time of switching on 150% load as well as at the time of switching off the power supply.

16.3.2.3.3 **200% Load**

1	After completion of the test at 150% load, the transformer shall be fed with power which shall be a value so as to cause circulation of rated current in the primary with the secondary windings short circuited. This current shall be circulated for 1hour.
2	The current shall thereafter be increased to 200% of the rated current and be maintained for 5minute period. At the end of the 5minute period the power supply shall be switched off and the time of switching off recorded.
3	Thereafter the readings as indicated in clause 16.3.2.3.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top-oil, top and bottom radiator header oils and temperatures indicated by OTI and WTI shall also be recorded at the time of switching on the 200% load as well as the time of switching of the power supply.

16.3.2.4 **Determination of thermal time constant of the windings**: The thermal time constant of the primary and secondary windings under both rated load and overloads shall be verified during the temperature rise tests.

16.3.2.5 The temperature rise of the oil, windings and current carrying parts in air under both the overload conditions stipulated in clauses 16.3.2.3.2 and 16.3.2.3.3 above shall not exceed the values stipulated in clause 5.1(13) of this document. The windings hot-spot temperature under the overload conditions shall not exceed 115^0C.

16.3.2.6 **Testing and calibration of the temperature indicators**: The functioning of the OTI and WTI shall be verified during the tests described above. Both the OTI and WTI shall be recalibrated, where necessary, to reflect the respective temperatures correctly. In particular, the reading of the WTI shall be the same as the calculated value of the hot-spot temperature of the winding.

16.3.2.7 **Determination of the thermal time constant of the WTI**: The thermal time constant of the WTI shall be determined for comparison with the thermal time constant of the windings of the transformer, with respect to the transformer oil. For this purpose, the indications of the WTI and the OTI shall be recorded every minute during the first 1 hour from the instant the transformer is loaded. From the slope of the curve plotted with time on the x-axis and the difference between the readings of the WTI and the OTI at particular time on the y-axis, the thermal time constant of the WTI shall be determined.

16.3.3 Lightning Impulse Test

16.3.3.1 This test shall be done in accordance with IEC 60076-3. Each of the terminals of the primary and secondary windings shall be tested with the following:

1	Highest voltage for equipment Um (kV)	52	245/145
2	Lightning impulse withstand voltage (kV peak)	250	950/650

16.3.4 Test with lightning impulse, chopped on the tail

16.3.4.1 This test shall be done in accordance with IEC60076-3 with appropriate test voltage as stipulated in Clause 16.3.3.1 above.

16.3.5 Short Circuit Test

16.3.5.1 The short circuit test shall be conducted in accordance with IEC 60076-5 with the following schedule:

1. Insulation resistance of the windings with respect to the earth and the windings.
2. No load current
3. No load loss
4. Resistance of windings
5. Percentage impedance voltages.
6. Load loss
7. Voltage ratio
8. Di-electric test comprising:
   - Separate source voltage withstand test
   - Induced over voltage withstand test
9. Recording of Surge frequency Response Analysis (SFRA) at the highest (+10%), lowest (15%) and principal tapping as per IEC 60076-18.

16.3.5.2 The short circuit test may be performed either from the secondary side or the primary side. However test protocol need to be finalized with prior approval of the Engineer.

16.3.5.3 The transformer shall be subject to a total of seven shots in the following sequence:

1st Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at highest tap (+10%)
2nd Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the highest tap (+10%)
3rd Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at principle tap
4th Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the principle tap
5th Shot	Asymmetrical and symmetrical currents in M-phase and T-phase respectively at lowest tap (-15%)
6th Shot	Symmetrical and asymmetrical currents in the M-phase and T-phase respectively at the lowest tap (-15%)
7th Shot	Symmetrical currents in M-phase and T-phase at lowest tap (-15%)

16.3.5.4 The duration of each shot shall be 0.5s.

16.3.5.5 Measurements shall be done after each shot for the following:

1	Percentage impedance voltage
2	No-load current
3	No-load loss

16.3.5.6 Further testing and inspection of the transformer subjected to the short-circuit test shall be carried out as per IEC 60076-5 with the modification that:

1	The dielectric routine tests shall be at 100% of the original test value
2	The percentage impedance voltages measured after the short circuit test shall

	not vary by more than 2% from those measured before the sort circuit test.

16.3.5.7 On completion of the short circuit test the transformer shall be un-tanked for inspection of the core and windings. In case the inspection of the core and windings do not reveal any apparent defects and the results of the short circuit test, the values of percentage impedance voltages as also the results of the route tests done after the short circuit test are in order the transformer will be deemed to have passed the short circuit.

If any of the results of the tests are not in order or the inspection of the core and winding reveals any defects, then the transformer shall be dismantled for detailed inspection.

16.3.6 Measurement of acoustic sound level

Measurement of acoustic sound level of the transformer energized at rated voltage and frequency shall be carried out as per IEC60076-10.

16.3.7 Measurement of Partial discharge quantity

16.3.7.1 Partial discharge quantity of the windings shall be measured in accordance with IEC 60076-3.

16.3.8 Measurement of harmonic of no-load current

16.3.8.1 The magnitude of harmonics of no-load current, as expressed in percentage of the fundamental, shall be measured by means of a harmonic analyzer, in accordance with IEC 60076-1.

16.3.9 Test with lightning impulse, chopped on the tail:

16.3.9.1 This test shall be done in accordance with IEC 60076-3 with appropriate test voltage as stipulated in Clause 16.3.3.1 above.

16.4 **Type tests on parts, fittings and accessories**

16.4.1 Tests for motorized off circuit tap changer

16.4.1.1 Though there are no Indian Standards Specifications at present for motorized off-circuit tap-changer, the following test shall be carried out thereon in accordance with IEC 60214.

16.4.1.2 **Tests for temperature rise of contacts**: The test shall be carried out at rated current of 1250A. The temperature rise shall not exceed the limit specified in IEC 60214.

16.4.1.3 **Mechanical endurance test**: With the tap changer in oil, 1000 operations shall be done manually. An operation shall comprise moving the tap changer from one tap position to the next higher or low tap position. All the taps of the tap changer i.e. 10% position tap through to the 15% tap shall be covered during the test.

16.4.1.4 **Milli Volt drop tests**: The test shall be done both before and after the mechanical endurance test to access the condition of contacts. The variation in millivolt drop values shall not be more that 20%.

16.4.1.5 **Short Circuit current test**: The test shall be done in accordance with IEC60214 with short circuit currents of 4 kA r.m.s, each 5s duration.

16.4.1.6 **Dielectric tests**: The test shall be done in accordance with IEC 60214.

16.4.2 Condenser Bushings

16.4.2.1 The type tests shall be carried out in accordance with IEC 60137 on porcelain housing of the condenser bushings. The following shall constitute the type test:

1. Visual inspection
2. Verification of dimensions
3. Electrical routine test

4. Porosity test
5. Temperature cycle test
6. Bending test

16.4.2.2 The type tests shall be carried out in accordance with IEC 60137 on prototype of the condenser bushing. The following shall constitute the type test:

1. Wet power frequency withstand voltage test
2. Dry lightning impulse voltage test
3. Thermal stability test
4. Temperature rise test
5. Thermal short time current withstand test
6. Dynamic current withstand test
7. Cantilever load withstand test
8. Tightness test
9. Test of tap Insulation
10. Tightness at flange or other fixing device
11. Measurement of partial discharge quantity.

16.4.3 Bushing type current transformers

16.4.2.1 The bushing type current transformers shall be tested in accordance with IEC60044-1.

16.4.4 Buchholz relay

16.4.4.1 The Buchholz relay shall be tested in accordance with IS: 3637

16.4.5 Terminal connector

16.4.5.1 The terminal connectors shall be tested in accordance with IS: 5561

16.4.6 Temperature indicators

16.4.6.1 The following tests shall be conducted on prototypes of OTI and WTI:

1	Accuracy with reference to a standard instrument
2	Calibration of the indicators to reflect the actual temperature of the oil/ windings
3	Dielectric test at 2.5kV for 60s.
4	Vibration test.
5	Dust and water splash test to IP55 degree of protection.

16.4.7 Pressure Relief Device

16.4.7.1 The following tests shall be conducted on the prototype of the pressure relief device:

1. Air pressure test.
2. Leakage test
3. Contact rating and operation test
4. Dielectric test on contacts at 2.5 kV for 60s.

16.4.8 Radiators

16.4.8.1 The radiators shall be tested for air leakage at a pressure of 2.5 kg/cm^2. The pressure shall remain constant for 1h to indicate that there is no leakage.

16.5 **Insulating Oil**

16.5.1 The following tests shall be carried out in accordance with IEC60296 on the sample of new insulating oil for use in the prototype transformer:

1. Density at 27 ^{0}C
2. Kinetic viscosity at 27 ^{0}C
3. Interfacial tension at 27 ^{0}C
4. Flash point.
5. Neutralisation value (acidity)
6. Electric strength (with 2.5mm gap)
7. Dielectric dissipation factor (tan-delta)
8. Specific resistance at 27 ^{0}C and at 90 ^{0}C
9. Oxidation stability
10. Water content.

16.6 **Routine tests**

16.6.1 The following routine tests shall be undertaken on each transformer including the prototype unit in accordance with IEC 60076-1:

1. Visual examination
2. Insulation resistance measurement
3. Measurement of no load current
4. Measurement of no load loss
5. Measurement of resistance of the windings
6. Measurement of percentage impedance voltages
7. Measurement of load loss
8. Polarity test
9. Voltage ratio test.
10. Dielectric tests comprising:
    - Separate-source voltage with stand test
    - Induced over voltage with stand test.
11. Recording/ submission of SFRA as per IEC 60076.
12. Recurrent Surge Oscillogram (RSO) Test
13. Test for motorized off circuit tap changer

16.6.2 **Visual examination**: A general examination shall be made to check that the transformer conforms to the approved Drawings, various items are accessible for maintenance, the quality of workmanship and finish are of acceptable standards and all parts, fittings and accessories\are provided.

16.6.3 **Insulation resistance test**: The Insulation resistance of the windings with respect to the earth and between the windings shall be measured using a 5 kV Megger.

16.6.4 **Measurement of no-load current**: Measurement of no load current referred to the primary side shall be done at:

1. 90%, 100% and 110% of the rated voltage at the principal tapping, and

2. The appropriate tap voltage at the +10% and -15% tap positions.

16.6.5 **Measurement of no-load loss**: Measurement of no-load loss referred to the primary, side shall be done at:

1. 90%, 100% and 110% of the rated voltage at the principal tapping, and

2. The appropriate tap voltage at the +10% and -15% tap positions.

16.6.6 **Measurement of resistance of windings**: The resistance of the windings shall be measured at all tappings and computed at 75^0C.

16.6.7 **Measurement of percentage impedance voltages**: The percentage impedance voltages at 'principal', +10% tap and -15% tap positions shall be measured at rated current and at ambient temperature and computed at 75^0C.

16.6.8 **Measurement of load loss**: Load losses at rated current shall be measured at principal, +10% and -15% tap positions at ambient temperature and computed at 75^0C.

16.6.9 **Polarity test**: The polarity (subtractive) and marking of the terminals for the polarity shall be verified.

16.6.10 Voltage ratio test: Voltage ratio shall be measured at all tap positions.

16.6.11 Dielectric tests:

16.6.12 Induced over voltage withstand test: The test shall be done by applying the test voltage across the entire secondary winding as per IEC 60076-3.

16.6.13 Separate source voltage withstand test: The test voltage to be applied as under:

1	Highest voltage for equipment Um (kV)	52	245/145
2	Rated short duration power frequency withstand voltage (kV)	95	395/275

16.6.14 Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18. Tests on off-load tap-changer: The tests shall be conducted in accordance with IEC 60214.

16.6.15 During the routine tests of any unit if it is found that the sum of the measured losses (i.e. no-load and load losses) measured at the principal tapping (corrected to 750C) exceeds the maximum guaranteed value defined in Clause 5.1 (14), the transformer shall be rejected.

16.7 If the prototype of a transformer conforming to this document and rating has already been approved in connection with previous supplies to Indian Railways, fresh type testing may be waived at the discretion of the Employer, provided that no changes whatsoever in the design or materials used or the process of manufacture have been made.

However, the Employer reserves the right to conduct type tests, if he deems, it necessary to do so in the light of experience gained from previous supplies.

16.8 Only after approval of the original tracings of Drawings incorporating changes, if any, as a result of the prototype tests and clear written approval of the results of. the tests on the prototype is communicated by the Employer, to the successful bidder/manufacturer, shall he take up bulk manufacture of the transformer which shall be strictly with the same materials and process of manufacture as adopted for the prototype. In no circumstances shall materials other than those approved in -the design/Drawings and/or during the prototype testing be used for bulk manufacture-on the plea that they had been obtained prior to the approval of the prototype.

16.9 The bidder may quote his charges for short-circuit and temperature rise tests. No charges shall be payable, for any other type and routine tests.

16.10 Transformer before dispatch should be filled with Nitrogen/ dry air and provided with a gauge clearly visible for monitoring the pressure inside the tank.

17 TECHNICAL DATA

The following shall be furnished by the Contractor:

17.1 Calculations for:

1. Temperature rise of winding at rated current.
2. Hot-spot temperature of the winding at 150% and 200% rated loads for 15 min and 5 min respectively.
3. Thermal withstand capacity of the windings for a short circuit of 2 s duration.
4. Mechanical forces in respect of the following as per IEEMA (Indian Electrical & Electronic Manufacturer's Association) formulae:
   a) Asymmetrical short-circuit current.
   b) Hoop stress in primary and secondary windings.
   c) Compressive pressure in the radial spacers.
   d) Internal axial compressive force.
   e) Axial imbalance force.
   f) Radial bursting force.
   g) Resistance to collapse.
   h) Bending stress on clamping ring and densified wood.
   i) Maximum allowable torque on pressure screws for coil clamping bolts at the time of tightening, if any.
5. Flux density with the characteristic curve.
6. Maximum value of inrush current.

17.2 Drawings for:

1. Outline General Arrangement Drawing giving complete details of the transformer.
2. Arrangement of the core, windings and magnetic path.
3. Magnetizing characteristic of CRGO sheet steel.

17.3 The successful bidder/ manufacturer shall submit to Engineer for approval the following detailed dimensioned Drawings as per Indian Railways standard in sizes of 210 mm x 297 mm or any integral multiples thereof.

1. Outline general arrangement of the transformer indicating plan, front elevation, side elevation with all parts, fittings and accessories, electrical, clearances as well as salient guaranteed particulars.
2. Internal arrangement of the transformer indicating primary and secondary bushing lead connections, core to clamp to core-base bolting, and the locking arrangement of the core assembly with the tank.
3. Cross sectional view of the core and windings with material specifications and makes.
4. Detail of the pressure screws/oil dash-pot/coil clamping bolts or other devices and their location with materials specification.

5. Schematic view of the valves used on the transformer and the anti-theft device so as to prevent theft of oil.
6. Transport outlines dimensions.
7. General arrangements of the odd-circuit tap changer assembly with salient technical parameters.
8. Tap changer cubical layout.
9. Schematic diagram for driving of motorized off circuit tap changer via SCADA.
10. Name and rating plate of motorized off circuit tap changer.
11. General arrangement of marshaling box indicating protection and control equipment.
12. Wiring diagram of the marshaling box.
13. Schematic diagram of protection and control circuits in marshaling box with cable schedule.
14. Legend plate showing protection and control circuits for fitment into the marshaling box.
15. OIP condenser bushing for primary side including cross-sectional view, shed profile and salient electrical and mechanical characteristics.
16. OIP condenser bushing for secondary side including cross-sectional view, shed profile and salient electrical and mechanical characteristics.
17. Dimensional Drawing, V-I characteristic and rating plate for bushing type current transformers.
18. Rigid terminal connectors for primary side bushing terminal
19. Rigid terminal connectors for secondary side bushing terminal
20. Rating plate with diagram of connections, both in English and Hindi versions.
21. Details of radiators
22. Details of breather
23. External cable-run with cable schedule.
24. Any other Drawings which the successful bidder considers necessary.

17.4 After approval, six copies of each of the approved Drawings along with two sets of reproducible prints for each Drawing shall be supplied to each consignee(s).

17.5 Two copies of the “Operations and Maintenance manual” for each transformer shall be supplied.

18 CAPITALIZATION OF TRANSFORMER LOSSES (NOT APPLICABLE)

18.1 (Deleted).

19 SPARES

19.1 The contractor shall supply spares for 220 or 132 kV transformers listed below:

1. One primary bushing complete with parts, fitting and bushing type current transformer.
2. One secondary bushing complete with parts, fitting and bushing type current transformer.
3. One complete set of gaskets of all sizes required for use in the transformer.
4. One breather unit with silica gel.
5. One piece of radiator.

6. One each of terminal connectors for primary and secondary side bushing terminals
7. One set of valves
8. One pressure relief device.
9. One set of primary, secondary and tapping coil
10. One complete off circuit motorized tap changer

20 ERECTION, TESTING AND COMMISSIONING

20.1 The transformer shall be erected and commissioned by the successful bidder. The manufacturer shall invariably make available at site the services of an engineer of his to ensure, by his continued presence, that the process of erection, testing and commissioning of the transformer is in accordance with established and recommended practices. For this purpose, prior intimation regarding the dates/period and locations at which the transformers are to be erected and testing/commissioning done shall be given by the bidder to the manufacturer.

21 SCHEDULE OF GUARANTEED PERFORMANCE, TECHNICAL AND OTHER PARTICULARS (GUARANTEED PARTICULARS ARE TO BE ESTABLISHED BY ACTUAL TESTS/ TEST REPORTS)

SN		DESCRIPTION	UNIT OF MEASUREMENT	VALUE/ INFORMATION
1		2	3	4
A		**RATINGS/PARTICULARS**		
1.		Name of the Manufacturer		
2.		Country of manufacture		
3.		Reference to specification based on which performance data is prescribed		
4.		Rated power	MVA	
5.		Primary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
6.		Secondary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
7.		Rated voltage :		
		a) Primary	kV	
		b) Secondary (at no-load)	kV	
8.		Rated frequency	Hz	
9.		Temperature rise above ambient temperature of 50 ^{0}C :		
	(i).	Oil :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
	(ii)	Winding :		
		a) At rated load ^{0}C		
		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
10		Hot-spot temperature of winding over ambient temperature of	^{0}C	
		a) At rated load	^{0}C	

		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
		Interval of time between two successive overloads after continuous working at full load, at maximum ambient temperature of 50°C:		
		a) Between two consecutive over min. loads of 50% for 15 min	min.	
		b) Between two consecutive min overloads of which one is of 50% for 15 min and the other of 100% for 5 min.	min.	
11		No-load current referred to primary side at rated frequency and at:		
		a) 90% rated voltage A		
		b) Rated voltage A		
		c) 110% rated voltage A		
12		Power factor of no-load current at rated voltage and rated frequency		
13		Value of the inrush current at rated voltage on primary side, the secondary side being open circuited		
14		Losses:		
	(i)	No-load loss at rated frequency and at:		
		a) 90% rated voltage at the principal tapping.	kW	
		b) rated voltage at the principal tapping.	kW	
		c) 110% rated voltage at the primary tapping.	kW	
	(ii)	Load loss (at 75 ^{0}C) at rated current and frequency	kW	
		a) Principal tapping	kW	
		b) -15% tapping	kW	
		c) +10% tapping	kW	
	(iii)	Total losses at rated current and frequency		
		a) Principal tapping	kW	
		b) -15% tapping	kW	
		c) +10% tapping	kW	
15		Resistance voltage (at 75 ^{0}C) at rated current	%	
16		Reactance voltage (at 75 ^{0}C) at rated current and frequency	%	
17		Impedance voltage (at 75 ^{0}C) at rated current and frequency	%	
18		Resistance (at 75 ^{0}C) of primary winding	ohm	
19		Resistance (at 75 ^{0}C) of secondary winding	ohm	
20		Reactance of winding :	H	
	a)	Primary at	H	
		a). Principal tapping	H	
		b). +10% tapping	H	
		c). -15% tapping	H	
	b)	Secondary	H	
21		Regulation (at 75 ^{0}C) with rated current and at power factor of:		
		a) Unity	%	
		b) 0.8 lagging	%	
22		Efficiencies:		
	(i).	Efficiency (at 75 ^{0}C) at unity power factor at:		

		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(ii).	Efficiency (at 75^{0}C) at 0.8 power factor lagging at:		
		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(iii)	Percentage of rated load at which maximum efficiency occurs.	%	
23		Ability to withstand short-circuit:		
		a). Thermal	s	
		b). Dynamic	s	
24		Thermal time constant (calculated):		
	(i)	for winding with respect to oil at:		
		a). rated current	min	
		b). 150% rated current	min	
		c). 200% rated current	min	
	(ii)	Complete transformer at rated current	min	
25		Temperature gradient between oil and winding at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min.	^{0}C	
26		Temperature rise of oil:		
	(i).	Calculated average temperature rise of oil at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min	^{0}C	
	(ii)	Estimated temperature rise of top oil at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min	^{0}C	
27		Details of core:		
	(i)	Type of core		
	(ii)	Flux density at rated voltage and frequency	tesla	
	(iii)	Flux density at 110% rated voltage and frequency	tesla	
	(iv)	Thickness of steel stampings	mm	
	(v)	Grade of core material and conforming specification		
	(vi)	Exciting VA/kg for core stampings at:		
		a) Flux density of 1.70 tesla	VA/kg	

		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	VA/kg	
	(vii)	Exciting VA/kg for assembled core at:		
		a) Flux density of 1.70 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	Va/kg	
	(viii)	Type of Insulation between core laminations.		
	(ix)	Type of joint between the core limbs and yoke.	kV	
	(x)	Core bolt Insulation withstand voltage	kV	
	(xi)	Core bolt Insulation flashover voltage	kV	
		Details of windings:		
28	(i)	Type of winding		
		(a) Primary		
		(b) Secondary		
		(c) Number of turns of primary winding		
		(d) Number of turns of secondary winding		
		(e) Number of parallel paths in primary winding		
		(f) Number of parallel paths in secondary winding.		
		(g) Is interleaving/inter shielding of the winding adopted to ensure better impulse voltage distribution?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(h) Is the Insulation of end turns of winding reinforced?	Yes/No	
	(i)	Primary		
	(ii)	Secondary		
		(i) Type of coil		
	(ii)	Mode of connection (i.e. in series or in parallel) of the portions of the windings on the two limbs of the core, if applicable.		
	(iii)	Dimensions of the copper conductor used in the winding:		
		a) Primary	mm x mm	
		b) Secondary	mm x mm	
		c) Tapped winding.	mm x mm	
	(iv)	Current density at rated current.		
		a) Primary	A/mm^2	
		b) Secondary	A/mm^2	
	(v)	Insulation used over the conductor (details of material and specification there for)		
	(vi)	Type of joints, if any, in the windings		
	(vii)	Dielectric strength of windings:		
		a) Full wave lightning impulse withstand voltage:		
		i) Primary winding	kV peak	
		ii) Secondary winding.	kV peak	
		(b) Lightning Impulse chopped on the tail withstand voltage:	kV	

		(i) Primary winding		
		(ii) Secondary winding		
		(c) Separate source power frequency withstand voltage	kV	
		(i) Primary		
		(ii) Secondary		
		(d) Induced over voltage withstand value		
	(viii)	Minimum flashover distance to earth in oil of :		
		a) Secondary winding to core		
		b) Primary winding to yoke		
		c) Primary winding to tank		
	(ix)	Material used for coil clamping rings and specification there for		
	(x)	Magnitude of axial pre-compressive force on the winding		
		(a) Primary	kV peak	
		(b) Secondary	kV peak	
	(xi)	Calculated maximum axial thrust in the winding due to dead short circuit at the terminals		
		(a) Primary		
		(b) Secondary		
	(xii)	Calculated short circuit forces:		
		a) Hoop stress in primary winding	kgf/cm^2	
		b) Hoop stress in secondary winding	kgf/cm^2	
		c) Compressive pressure in the radial spacers		
		d) Internal axial compressive force	kgf/cm	
		e) Axial imbalance force		
		f) Resistance to college	kgf	
		g) Bending stress on clamping	kgf/cm^2	
		h) Radial bursting force		
	(xiii)	Arrangement to maintain constant pressure on the windings		
	(xiv)	Maximum permissible torque on pressure screws for coil clamping at the time of tightening, if any.	N.m	
	(xv)	Can either end of each secondary winding (25 kV) be connected directly to earth?	Yes/No.	
29		Motorised off-circuit tap changer:		
		a) Name of the manufacturer		
		b) Country of origin.		
		c) Type designation		
		d) Governing specification.		
		e) Is a separate taped winding provided on primary?		
		f) Number of tappings:		
		i) Plus tappings		

		ii) Minus tappings		
		g) Percentage variation of voltage on different tapping.		
		h) Minimum contact pressure between moving and stationery contacts	kgf	
		i) Maximum rated through current	A	
		j) Voltage class	kV	
		k) Rated voltage of control circuit	V(dc)	
		l) Tap changer motor particulars:		
		i) Make and type		
		ii) Rated voltage	V(dc)	
		iii) Rated current	A	
		iv) Rated power	kW	
		v) Speed	rpm.	
		vi) Class of Insulation		
30		Bushings:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation (specify as to whether it is OIP condenser bushing)		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV peak	
		i) Lightning impulse withstand voltage	mm	
		j) Creepage distance		
		k) Weight of assembled bushing	Kg	
	(ii)	Secondary side		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV	
		i) Lightning impulse withstand voltage	kV peak	
		j) Creepage distance	mm	
		k) Weight of assembled bushing	kgf	
31		Bushing type current transformers:		
	(i).	Primary side:		
		a) Name of the manufacturer		

		b) Governing specification		
		c) Transformation ratio		
		d) Accuracy class and rated accuracy limit factor		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C	ohm	
		j) Short time thermal current and duration.	kA, s	
	(ii)	Secondary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ration		
		d) Accuracy class		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^0C.	ohm	
		j) Short time thermal current and duration	kA, s	
32		Insulating oil :		
		a) Governing specification		
		b) Grade of oil		
		c) Source of supply		
		d) Specific resistance at:		
		i) 27 ^{0}C	ohm-cm	
		ii) 90 ^{0}C	ohm-cm	
		e) Dielectric, dissipation factor (tan-delta) at 90 ^{0}C		
		f) Dielectric strength	kV	
		g) Water content	ppm	
		h) Interfacial tension	N/m	
		i) Neutralization value	mg KOH/gm	
		j) Flash point	°C	
33		Type of transformer tank		
34		Details of radiators:		
		a) Make and type		
		b) Type of mounting		
		c) Overall dimensions (LxWxH)	mmx mm x mm	
35		Details of Buchholz relay:		
		a) Make and type		
		b) Governing specification		
		c) Provision of shut-off valves on either side of the relay	Yes/No	

		d) Provision of alarm contact	Yes/No	
		e) Provision of trip contact	Yes/No	
		f) Rated current of contacts	A	
36		Details of winding temperature		
		Indicator.		
		a) Make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
37		Details of oil temperature indicator		
		a) make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
38		Details of Magnetic oil level gauge:		
		a) Make and type		
		b) Governing specification		
		c) Diameter of dial mm		
		d) Number of contacts provided		
		e) Rated current of contact	A	
		f) Dielectric withstand value of contacts	kV	
39		Details of pressure relief device:		
		a) Make and type		
		b) Governing specification		
		c) Does it reset itself	Yes/No	
40		Bimetallic terminal connectors:		
	(i)	Primary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45°C while carrying rated current.	°C	
		f) Short time current and duration	kA, s	
	(ii).	Secondary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45^0C while current rated current	°C	
		f) Short time current and duration	kA, s	

41		Acoustic sound level at a distance dB of 1 m, when energized at rated voltage and rated frequency without load.	dB	
42		Partial discharge value at 1.5Um/ 3 kV r.m.s.	pC	
43		Weights and dimensions:		
	(i)	Net weight of core		
	(ii)	Net weight of cooper:		
		a) Primary winding	kg	
		b) Secondary winding	kg	
	(iii)	Net untanking weight of core frame and coils	kg	
	(iv)	Net weight of insulating oil	kg	
	(v)	Volume of insulating oil	l	
	(vi)	Total weight of cooling equipment	t	
	(vii)	Total weight of transformer without oil	t	
	(viii)	Total shipping weight of complete transformer including all detachable parts, fittings and assemblies	t	
	(ix)	Shipping weight of largest package	t	
	(x)	Crane lift (excluding slings) for un-tanking core and coils	mm	
	(xi)	Crane lift (excluding slings) for removal of primary side bushings.	mm	
	(xii)	Dimensions of the complete transformer including all parts, fitting and accessories:		
		a) Overall length	mm	
		b) Overall breadth	mm	
		c) From rail level to the topmost point	mm	
	(xiii)	Minimum thickness of steel plate/ sheet used:		
		a) Tank Cover mm		
		b) Tank bottom mm		
		c) Conservator mm		
		d) Radiator mm		
		e) Marshaling box. mm		
	(xiv)	Overall shipping dimensions of the largest package (Length x width x height)	mm x mm x mm	
	(xv)	Mode of transportation of transformer unit (filled with oil/nitrogen gas.)		
		Other particulars		
44		Is the transformer tank fitted with lifting pads? If yes, what is the number of pads	Yes/ No	
45		What is the number of inspection covers provided?		
46		Are comfits/ trays provided for cable run?	Yes/ No	
47		Is the core electrically connected with the tank?	Yes/No	
48		Will the gaskets to be used in the transformer give trouble free service for at least 7 years? If not, indicate the life.	Yes/No	
49		Is the core construction without core bolts?	Yes/No	

50		Are the core bolts grounded, and if so, how?	Yes/ No	
51		What is the number of radial spacers used in the winding?		
52		What is the number of joints provided in the winding?		
53		Are the spacers/blocks/angle rings of pre-compressed press boards? If no, indicate the material with specification.		
54		Are arrangements made for ensuring automatic constant pressure on the coils? If no. give the reasons.	Yes/ No	
55		Are closed slots provided on outer most winding for locking the vertical strips? If no, give the reason.	Yes/ No	
56		What is the periodicity for tightening of coil clamping arrangement?	Years	
57		What are the designed values of short-circuit current for:		
		a) Symmetrical :		
		i) Primary winding A		
		ii) Secondary winding A		
		b) A symmetrical:		
		i) Primary winding A		
		ii) Secondary winding A		
58		What is the over flux withstand capability of the transformer (Maximum permissible limit of flux density)?	Tesla	
59		Are windings pre-shrunk?	Yes/No	
60		Have the details of drying cycles of the coils/coil assembly including final tightening values of pressure, temperature and degree of vacuum at various stages of drying been furnished?	Yes/ No	
61		Are arcing horns provided for line and neutral bushings?	Yes/ No	
62		Is a test tap provided in the line bushing?	Yes/ No	
63		Is the porcelain housing of the bushings of single piece construction?	Yes/ No	
64		Is the shed profile of porcelain housing of the bushing free from under-ribs but has a lip?	Yes/ No	
65		Is the bushing type current transformer of low reactance type?	Yes/ No	
66		Is Clause by Clause "Statement of compliance" attached?	Yes/ No	
67		Does the tap changer have snap action? If not, give reason.		
68		Is the Buchholz relay provided with two shut-off valves, one on either side?	Yes/ No	
69		Is separate conservator tank & Buchholz relay provided for tap changing equipment?	Yes/ No	
70		Are fasteners of 12 mm diameter and less exposed to atmosphere of stainless steel to Grade 04Cr17 Ni12Mo to IS 1570 Part-V?	Yes/ No	
71		Are the fasteners of more than 12 mm diameter exposed to atmosphere of stainless steel or MS hot dip galvanized?	Yes/ No	
72		Are test certificates for tests as per Clause 15.0 attached?	Yes/ No	
73		Are all the calculations required as per clause 16enclosed?	Yes/ No	

74		Are all the Drawings required as per clause 16 attached?	Yes/ No	
75		(a) Are all the parts, fittings and accessories from RDSO's approved manufacturers?	Yes/ No	
		(b) If not, list the items which are to be type tested in the presence of Employer's Personnel.	Yes/No	
76		Is adequate space provided in the marshaling box for housing the wiring and components?	Yes/ No	

****

(Annexure – I)

TECHNICAL SPECIFICATIONS FOR NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM FOR OIL FILLED TRANSFORMER

1.0 GENERAL DESCRIPTION

Nitrogen injection fire protection system designed for oil filled transformers shall prevent tank explosion and the fire during internal faults resulting in an arc, where tank explosion will normally take few seconds after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion and/or external failures like bushing fires, OLTC fires and fire from surrounding equipment's.

The system shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

Conservator tank oil shall be isolated during bushing bursting, tank explosion and oil fire to prevent aggravation of fire.

Transformer isolation shall be an essential pre-condition for activating the system. The system shall be designed to operate automatically. However, it shall be designed for manual operation, in case of failure of power supply.

The system shall consist of following equipment:

1. Fire extinguishing cubicle placed on a plinth at about 5-10 meter away from the transformer.
2. Control box placed in the control room.
3. Necessary valves in the conservator pipe.
4. Suitable fire sensing components to be provided preferably in/on the tank cover.
5. Signal box suitably placed.

2.0 SCOPE

The scope of this document covers design, engineering, supply testing at works before dispatch; erection, testing and commissioning and performance demonstration of "fire protection and extinguishing system by nitrogen injection method".

The necessary civil work which will be required for construction of oil soak – pit for the storage of oil coming out from the transformer and plinth for extinguishing cubicle is included in the scope of this work. Laying of oil pipe, nitrogen pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary vales, fire detectors and other equipment & accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the Tenderer. It will be the responsibility of the Tenderer, i.e. transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests. Notwithstanding the technical specifications and requirements mentioned herewith any modification can be incorporated for correct operation of nitrogen injection fire protection system without extra cost. The full details of the same are required to be submitted to Employer for approval, when first unit is implemented on a transformer of specific make & rating.

3.0 OPERATIONAL CONTROLS

The system shall be provided with automatic control for fire prevention and fire extinction. Besides automatic control, remote electrical push button control on control box and local manual control in the fire-extinguishing cubicle shall be provided. The fire protection system will take signal from HV/LV circuit breaker.

4.0 SYSTEM ACTIVATING SIGNALS

4.1 Transformer isolation shall be an essential pre-condition for activating the system. Provision shall be provided to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before Nitrogen injection and after oil depressurization.

4.2 There shall be two modes of operation of Fire Protection System i.e. Fire Prevention Mode & Fire Extinction Mode. In these modes the safety equipment to be involved are tabulated below. The logic of their operation shall be finalized during design approval.

Mode of Operation	Safety Equipment to be used
Fire Prevention Mode	• Differential relay/Over current/Restricted earth fault relay. • Pressure relief valve
Fire Extinction Mode	• Fire sensing components • Buchhloz relay

5.0 SYSTEM EQUIPMENT

5.1 Fire Extinguishing Cubicle (FEC), placed on plinth at about minimum 5 meter away from the transformer shall consist of:

5.1.1 Nitrogen gas cylinder with pressure reducer/regulator and falling pressure electrical contact manometer.

5.1.2 Oil drain pipe with mechanical quick drain valve;

5.1.3 Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.

5.1.4 Pressure monitoring switch for backup protection, pressure reducer with solenoid valve in the cabinet for operation of nitrogen gas release, which will be IP-65, protected and leak proof for nitrogen release.

5.1.5 Limit switches for monitoring of the system.

5.1.6 Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.

5.1.7 Panel lighting

5.1.8 Oil drainpipe extension of suitable sizes for connecting pipes to oil pit.

5.1.9 The Nitrogen gas cylinder should be of sufficient (not less than 50 liter) capacity and should be filled at a pressure of not less than 150 bars with falling pressure electrical contact manometer, suitable design measures to prevent leakage of gas to be taken.

5.1.10 The nitrogen valve shall have IP-65 protection. The nitrogen shall be contained within the cylinder and released from the cylinder valve only upon activation of the fire protection system. Nitrogen purity shall 99.99%

5.1.11 Proper approvals and certificates should be provided with each cylinder. No used nitrogen bottle will be accepted.

5.2 Control box with activating, monitoring devices and line faults indicators to be placed in control room. It should have audio-visual alarm indication and push button switches for tests response.

5.3 Necessary valves to be fitted in the conservator pipeline between conservator and Buchholz relay operating mechanically on transformer oil flow rate with electrical signal for monitoring.

5.4 Suitable fire sensors to be fixed on transformer tank top cover and off circuit tap changer for sensing fire.

5.5 Signal box to be fixed on transformer side will for terminating cable connection from sensors and conservator shutter/signal box to be suitably placed.

5.6 All other consumables necessary for operation of complete system.

5.7 Control box should be microprocessor based and compatible to be interfaced with existing RTU for Railway Traction SCADA system available at the control room. For communication, Control box shall have provision for interfacing with SCADA in this regards details Digital Input & Output required for operation monitoring through SCADA should be furnished.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION

6.1 Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.

6.2 Flanges with dummy piece in conservator pipe between Buchhloz relay and conservator tank for fixing.

6.3 Brackets on transformer top cover for sensing equipment, valves to enable operation of the system.

6.4 Spare potential free contacts for system activating signals i.e. differential relay, Buchholz relay, pressure relief valve, transformer isolation (master trip relay).

6.5 Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

6.6 Cabling on transformer top cover all sensors to be suitably connected for reliable fire sensing and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

6.7 Plinth for fire extinguishing cubicle. Oil pit with capacity as 10% of total oil quantity of transformer.

7.0 TECHNICAL DETAILS

Fire extinction period:

On commencement of Nitrogen injection	:	Maximum 30 seconds
On system activation up to post cooling	:	Maximum 3 minutes
Heat sensing area	:	140± 2°C
Seating for operation to isolate conservator	:	Min.60Ltr. per minute

Power Source:

Control Box	:	110 V DC

8.0 CABLING:

8.1 Fire survival cables, able to withstand 750°C, 1.5 mm² with necessary no. of conductors for connection of fire detectors in parallel shall be used. The test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between transformer signal box/marshaling box to control box and control box to fire extinguishing cubicle shall be used.

8.3 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/marshaling box to transformer shall be used.

9.0 PREVIOUS EXPERIENCE FOR QUALIFYING SUPPLIER

The supplier shall have a minimum experience of two years in the design, manufacturing, erection, testing and commissioning of Nitrogen Injection Fire Protection System on power transformers of similar or higher rating. At least 2 sets of the system shall be in successful operation for a minimum period of the 2 years. The supplier shall furnish the details of Nitrogen Injection Fire Protection System supplied by them so far, giving order reference, name and address of the customer, indicating the dates of commissioning as well as performance certificate of successful and satisfactory operation for minimum two years from the customers.

10.0 TESTS

10.1 Type Tests

Type test reports including that for detectors along with declared response time as per test approval certificate letter shall be submitted by the contractor.

The system shall be tested by international or a national testing body (NABL accredited recognized laboratory. Tariff Advisory Committee (TAC's) approval, if any, shall be submitted.

10.2 Factory Test

Tests will be carried out on individual equipment of the system and the total system in the supplier's workshop in presence of Employer's Personnel.

10.3 Performance Test

Performance test of the complete system shall be carried out after complete erection at site by the supplier's representative. These tests shall include simulation and verification of the response of the complete system without actual draining of the oil and injection of the nitrogen gas.

In addition to above, additional tests as required necessary shall be conducted.

11.0 DRAWINGS AND MANUALS

After awarding of contract, detailed dimensional Drawing of the system complete bill of materials including location and size of plinth for cubicle and recommended capacity of oil soak-pit shall be submitted for Engineer's approval. After approval 10 (ten) sets of all above Drawings and 5 (five) sets of operation and Maintenance Instruction Manual (bound) shall be submitted for Employer's use.

12.0 SPARES

One full set of spares nitrogen filled cylinder, one set of the installed no. of fire sensors shall be provided in addition to additional other recommended spares. The list of recommended spares is to be submitted along with the tender.

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Annexure-XIV

Specification for 8 MVA, 54 kV, 50Hz AUTO TRANSFORMER FOR 2 X 25 kV AT FEEDING SYSTEM

1 SCOPE

1.1 This document applies to 8 MVA, ONAN, 54 /27 kV Autotransformer for Auto Transformer (AT) feeding system for Installation in DFCC

1.2 The transformer shall be complete with all parts, fittings and accessories whether specifically mentioned herein or not, necessary for its efficient operation in an unattended traction substation.

2 GOVERNING SPECIFICATION

2.1 In the preparation of this document, assistance has been taken from the following National and International Standards, wherever applicable.

Table No.: 2.1-1

Standards		Description
Equivalents	**IS**	
IEC 60076 (all parts)	IS:2026 (all parts)	Power transformers.
IEC 60044-1	IS:2705	Instrument transformer – Part 1: Curent transformer.
IEC 60137	IS:2099	Bushing for alternating voltages above 1000V
IEC 60214	IS:8468	Tap changers.
IEC 60296	IS:335	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear/ New insulating oils.
	IS:5	Colors for ready mix paints and Enamels.
IEC 60502-1	IS:1554 (Part 1)	PVC insulated (heavy duty) Electric cables: Part 1 For working voltages up to and including 1100V
	IS:1570	Schedules for Wrought Steels - Part 5: Stainless and heat resisting steels.
	IS:1576	Solid pressboard for electrical purposes
IEC 60422	IS:1866	Code of practice for electrical maintenance and supervision of mineral insulating oil in equipment
	IS:2927	Brazing alloy
JIS C 2553	IS:3024	Grain orient electrical steel sheets and strips
	IS:3637	Gas operated relays
	IS:3639	Fittings and accessories for power transformers
	IS:4253	Cork composition sheets : Part 2 Cork and Rubber
	IS:5561	Electrical power connectors
	IS:5621	Hollow insulators for use in electrical equipment
IEC 60909	IS:13234	Guide for short circuit calculations in 3Phasea.c. systems.

IEC 60270	IS: 6209	High-voltage test techniques - Partial discharge measurements.
IEC 60076	IS:6600	Guide for loading of oil-immersed transformers
	IS:10028 (all parts)	Code of practice for selection, installation and maintenance of transformers
	IS:10593	Mineral Oil-impregnated electrical equipment in services - Guide to the interpretation of dissolved and free gases analysis
IEC 60137	IS: 12676	Oil impregnated paper insulated condensers bushings – dimensions and requirements
	DIN:7733	Laminated products, pressboard for electrical engineering, types
		Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010, part-III, Sec.4, 2010 Rule no. 44 (2) (ix).

2.2 In case of any conflict between the contents of the above standards and this document the latter shall prevail.

3 CLIMATIC AND ATMOSPHERIC CONDITIONS

3.1 The transformer shall be suitable for outdoor use in moist tropical climate and in areas the limiting weather conditions which the equipment has to withstand in service are given in clause 4.2, Chapter- 4 of this Specification.

3.2 The transformer shall also be subjected to vibrations on account of trains running on nearby Railway tracks.

The amplitude of these vibrations which occur with rapidly varying time periods in the range of 15 to 70 ms lies in the range of 30 to 150 microns at present, with the instantaneous peaks going up to 350 microns. These vibrations may become more severe as the speeds and loads of trains increase in future.

4 TRACTION POWER SUPPLY SYSTEM (2x25 kV AT FEEDING SYSTEM)

4.1 General Scheme

4.1.1 The electric power for railway traction is supplied in ac 50 Hz, single-phase through 2x25 kV AT feeding system, which has a feeding voltage (2x25 kV) from the traction substation (TSS) two times as high as the catenary voltage, which is 25 kV with respect to earth/rail. The power fed from the TSS through catenary and feeder wire is stepped down to the catenary voltage by means of autotransformers (ATs) installed about every 13 to 17 km along the track, and then fed to the locomotives. In other words, both the catenary and feeder voltage are, 25 kV with respect to the earth/rail, although the substation feeding voltage between catenary and feeder wires is 50 kV. The catenary voltage is therefore, the same as that in the conventional 25 kV system.

4.1.2 The power supply shall be obtained from the 220 or 132 kV, three-phase, effectively earthed transmission network of the State Power to the Scott-connected transformer installed at the TSS, whose primary winding is connected to the three phases of the transmission network. The spacing between adjacent substations is normally 60 km.

4.1.3 One outer terminal of the secondary windings of the traction transformer is connected to the catenary and the other outer terminals are connected to the feeder.

4.1.4 ATs connect the 25 kV catenary to 25 kV return feeder, with mid-point connected to rail and

earth (25 kV return OHE and earth). Two adjacent AT's share power to feed trains at 25 kV/2x25 kV system feeds 50 kV supply from traction transformer terminal to the ATs. The load current (current drawn by electric locomotives) from the TSS flows through the catenary and returns to the TSS through the feeder. For a train in an AT-cell (distance between two consecutive ATs), most of the current is fed to the electric locomotive by the ATs of that AT-cell; the, current returns in the rails/earth and is boosted up to the feeder through the neutral terminals of the autotransformers. The current in OHE, therefore, is an algebraic sum of 25 kV current feed to locomotives from AT and the 50 kV supply to ATs from the TSS.

4.1.5 Approximately midway between adjacent TSSs, a sectioning and paralleling post (SP) is provided. In order to prevent wrong phase coupling of power supply, a dead zone known as 'Neutral Section' is provided in the OHE opposite the TSS as well as SP. At the TSS, there are two-feeder circuit breakers for either side of the TSS for controlling the power fed to the OHE, in a double track section. Out of the two feeder circuit breakers for one side, one feeds the OHE of that side while the other remains (open) as standby. There is also a paralleling interrupter, which is normally closed, for either side of the TSS for paralleling the OHE. In case of fault in the OHE, the feeder circuit breaker of the TSS trips to isolate it. The Bridging Interrupter is used to feed one TSS up to the next TSS, in case the adjacent TSS is temporarily out of order.

4.1.6 For maintenance work and keeping the voltage drop within limit, one or more sub-sectioning and paralleling post (SSP) are provided between the TSS and SP. The supply control Posts are on an average located every 13-17 km interval. An SSP has four sectioning interrupters and one paralleling interrupter, whereas an SP has two bridging circuit breakers (which remain open under normal feeding condition) and two paralleling interrupters.

4.2 Protection System

4.2.1 The Protection system of the traction transformer comprises the following:

1	Differential protection
2	Instantaneous and IDMT over-current, and earth fault protection on the primary side
3	Protection against phase-failure on the secondary side (i.e. to detect malfunction of feeder/transformer circuit breaker)
4	Buchholz Relay
5	Thermistor/Optical hot spot sensor. The Transformer should have built-in hottest spot temperature device to indicate and record the hot test spot temperature as per IEC-60076-2 (Ed. 3.0).

4.2.2 The protection system for the OHE comprises the following:

1	Distance protection
2	Delta I type fault selective protection
3	Instantaneous over current protection
4	Under-voltage protection to avoid wrong phase coupling
5	Fault locating expert system based on AT voltage neutral current.

4.3 OHE General data

4.3.1 The OHE shall consists of **(i)** Contact wire of minimum 150 mm^2 cross section suspended directly from catenary of wire of minimum 120 mm^2 cross section by a number of vertical dropper wires, usually at regular intervals and **(ii)** a feeder wire of stranded all aluminum conductor.

4.4 Auto Transformer General Data

4.4.1 The transformer shall have Minimum 8 MVA power rating based on ONAN cooling or higher as confirmed by simulation results. The Contractor shall develop the Technical Specifications for higher Capacity MVA Auto transformers based on this specification and get it approved from

the Engineer.

4.5 Nature of traction loads and faults on the OHE system

4.5.1 The traction load is a frequently and rapidly varying one, between no load and overload. The TSS equipment is subject to frequent earth faults/short circuits caused by failure of Insulation, snapping of OHE touching earth, wire dropped by bird connecting the OHE to earth/ over line structure, and miscreant activity. On an average, the number of faults/ short circuits per month could be as high as 40. The magnitude of the fault current may vary between 40% and 100% of the dead short circuit value. These faults are cleared by the feeder circuit breaker on operation of the distance, delta I and instantaneous over-current relays associated with the concerned feeder circuit breaker. In 2x25 kV system faults can occur with: feeder-earth; feeder-OHE and OHE-earth faults or a combination of them.

4.5.2 The existing Indian Railways ac electric locomotives are silicon rectifiers, with dc motors or GTO/IGBT based power converter fed 3-phase Induction Motor and the average power factor generally varies between 0.7 and 0.85 lagging, without reactive power compensation, which introduces harmonic currents in the 25 kV power supply system.

4.5.3 On DFCC (Eastern) Locomotives are proposed to have VVVF drives and improved power factor closer to 0.98 and negligible harmonics. The traction supply may therefore be at higher power factor than those on IR.

4.6 Short-circuit apparent power of the system

4.6.1 The short-circuit apparent power at the transformer location for various system voltages is as under:

Highest system voltage (kV)	Short circuit apparent power, (MVA)
72.5	3,500
123	6,000
145	10,000
245	20,000

4.7 Auxiliary power supplies at TSS

4.7.1 The following auxiliary power supplies are available

1	110V dc from a battery
2	240 V ac, 50 Hz, single-phase from a 25/0.24 kV auxiliary transformer feed from Traction supply.

5 RATING AND GENERAL DATA

5.1 The rating and general data of the auto transformer shall be as follows:

SN	Item	Description
1.	Type	ONAN cooled, single-phase autotransformer with Centre tapping (neutral terminal), double limb wound, core-type for outdoor installation
2.	Winding	One winding with Centre tapping, uniformly insulated, shall be provided. The outer (line) terminals of the winding shall be brought out through 54 kV class bushings, whereas the neutral terminal (Centre tapping) through 12 kV class bushing.
3.	Rated frequency, Hz	50 ±3%
4.	Rated primary voltage, kV	54
5.	Maximum primary voltage, kV	60
6.	Rated secondary voltage (at no-load), kV	27

7.	Rated power, MVA	8 MVA ONAN		
8.	Rated current			
	1) Rated primary current, A	148		
	2) Rated secondary current, A	296		
9.	Maximum leakage impedance as seen from secondary side	0.45 ohm		
10.	Non-cumulative overload capacity after the transformer has reached steady temperature on continuous operation at rated load (i.e.at rated power)	150% rated load for 15 min 200% rated load for 5 min		
11.	Temperature rise	1. Winding: 50K at rated load, and 60K for overloads as specified in Clause 5.1(10) (Temperature measured by resistance method). 2. Top oil: 45K (temperature rise measured by thermometer) 3. Current carrying parts in air: 40K (temperature rise measured by thermometer).		
12.	Maximum permissible losses			
	1. No-load loss, kW as per IEC 60076-1 clause 3.6.1	7.5 kW		
	2. Load loss, kW as per IEC 60076-1 clause 3.6.3	26.5 kW		
	3.Total losses as per IEC 60076-1 clause 3.6.4	34 kW		
13.	Short circuit current (symmetrical)	25 (Twenty five) or 35 (Thirty five) times of the rated current.		
14.	Ability to withstand short circuit current of 25 (Twenty five) or 35 (Thirty five) times of the rated current			
	1. Thermal ability	5s		
	2. Dynamic ability	0.5s		
15.	Flux density at rated voltage and frequency	Shall not exceed 1.55 Tesla.		
16.	Current density in the windings at rated current	Shall not exceed 2.5 A/mm^2		
17.	Acoustic sound level when energized	NEMA Standard TR-1-1993 (R2000) Table - 2		
18.	Bushing	Item	Line terminals	Neutral terminals
		Type	OIP condenser	Solid or Liquid filled porcelain
		Highest voltage for equipment Um(kV)	52	12
		Rated current(kV)	800	800
		Minimum Creepage distance in air(mm)	1300	300
19.	Bushing type current transformers on neutral transformer for fault locator:			
	1. Highest voltage for equipment Um, kV	12		
	2. CT ratio	500/5		
	3. Frequency, Hz	50 ± 3%		

	4. Rated output, accuracy class and accuracy limit factor as per IEC60044-1	30VA Class 5P15
	5. Minimum knee-point emf, V	125
	6. Maximum excitation current at knee-point voltage, A.	0.25
	7. Maximum resistance of the secondary winding When corrected to 75 ℃, ohm	0.25
	8. Rated short-time thermal current	25 kA for one second
	9. Rated dynamic current	62.5 kA (peak)

6 SALIENT DESIGN FEATURES

6.1 Overall dimensions

6.1.1 The overall dimensions of the transformer shall be kept as low as possible and in any case shall not exceed the transportation limit.

(Transportation dimension)

1	Length x Width (in mm)	14,000 x 6,500
2	Height of topmost point of primary bushing terminal	7,500 mm
3	Height of topmost point of secondary bushing terminal	5,500mm

6.1.2 The manufacture shall, where practical, design the transformer so that with the bushings & accessories removed, the transformer shall fit within Indian Railway loading gauge, in case it is transported through rail, MMD to be enclosed with the offer.

6.1.3 The transformer should be designed nitrogen filled or dry air, such that it can be transported without the Insulation oil inside the tank. The transformer shall be designed such that it can be transported with tank under pressure with nitrogen and other protective measures that the Manufacturer recommends, so that no moisture can enters the housing.

6.2 Tank

6.2.1 The tank for the transformer shall be of the top cover jointed with bolted connection. The bottom plate of main tank shall be firmly welded to the main body and the top cover is a plate reinforced with ribs. This is subject to quality and life of windings which does not require any retightening after energized in field. A pressure gauge along with a hygrometer shall be provided so that the status of dryness of the winding can be assessed in the transformer prior to its heat run before commissioning.

6.2.2 The tank shall be constructed from mild steel of a quality that- allows welding without any defect/flaw, with a single tier construction, so shaped as to reduce welding to the minimum. The welded joints shall be made using the latest welding techniques. The tank shall be adequately strengthened for general rigidity to permit hoisting of the transformer filled with oil by crane. The tank body shall be designed to withstand full vacuum degree.

6.2.3 The tank shall be fitted with four lifting pads at the lower end to enable lifting of the transformer filled with oil by means of lifting jacks.

6.2.4 The tank shall be fitted with an under carriage and mounted on bidirectional swiveling type flanged rollers for being rolled on 1676mm (5'6") gauge track on which it shall also rest in the

final position. The rollers shall be provided with detachable type locking arrangement to enable their locking after installing the transformer in the final position, to hold the transformer fixed on foundation and to prevent any accidental movement of the transformer.

6.2.5 There shall be at least three inspection covers of suitable size on the tank to enable inspection of the lower portions of bushings, and the leads as well as the various connections inside the tank.

6.2.6 The gaskets with groove NBR (NITRILE BUTADIENE RUBBER) shall be provided for oil sealing points. The rubberized cork gasket may be used for other general portion.

6.2.7 All valves used in the transformer shall be capable to withstand full vacuum degree, conform to IS-3639. The manufacturer shall ensure that suitable anti-theft measures like locked use of blanking plates are provided on these valves, so as to prevent theft of oil during transit and service.

6.3 Marshaling box

6.3.1 A vermin proof, weatherproof and well ventilated, marshaling box with IP class 55, made up of sheet steel of thickness not less than 2 mm, strengthened with adequate stiffeners, shall be provided on the left hand side of the transformer tank as viewed from the secondary terminals side. It shall have a hinged door, with provision for padlocking the door opening outward horizontally.

6.3.2 THze marshaling box shall have a sloping roof. The top of the marshaling, box shall be at a height of about 2m from the transformer rail level.

6.3.3 The marshaling box, shall house the winding and oil temperature indicators and terminal board. To prevent condensation of moisture in the marshaling box, metal clad space heater controlled by an associated thermostat and switch shall be provided. Cable glands shall be provided for the incoming and outgoing cables.

6.3.4 The temperature indicators shall be so mounted such that their dials are at a height of not more than 1.6 m from the rail level. Transparent windows of tough acrylic plastic or similar non-fragile transparent material shall be provided on the marshaling box, so as to enable reading of the temperature indicators without opening the door of the marshaling box.

6.3.5 All cables from the bushing current transformers, magnetic oil level gauge, pressure relief device and temperature indicators shall be run up to the marshaling box. The cables shall be of 1100 V grade, XLPE insulated, XLPE sheathed, steel wire armored, stranded copper conductor conforming to IEC 60502-1. The cables shall be adequately insulated for heat from the tank surface and the sun.

6.3.6 All wiring in the marshaling box shall be clearly identified by lettered/figured ferrules of the interlock type, preferably of yellow colour with-black letters/figures. The ac and dc circuits shall be clearly distinguished and well separated from each other.

6.3.7 Suitable legend and schematic diagram plates made of anodized aluminum with black lettering and lines shall be fixed on the inside surface of the marshaling box door.

6.4 Core

6.4.1 The core shall be built-up of high permeability cold rolled grain oriented silicon steel laminations conforming to JISC 2553 or equivalent IS as indicated in Table No. 2.1-1. The flux density in any part of the core and yokes with primary winding excited at the rated primary voltage and frequency; shall not exceed 1.55T. The successful bidder / manufacturer shall furnish calculations to prove that this value shall not be exceeded.

6.4.2 The lamination for the core shall be free from waves, deformations and signs of rust. Both sides of the laminations shall be coated with suitable Insulation capable of withstanding stress relief annealing. In assembling the core, air gaps shall be avoided. Necessary cooling ducts shall be provided in the core and yoke for heat dissipation The core clamping frame shall be provided with lifting eyes for the purpose of tanking and un-tanking the core and winding of the transformer.

6.4.3 The core shall be electrically solidly connected to the tank.

6.4.4 Design of the Core shall be boltless and it shall be tightened by binding the laminations using resin glass type. Core laminations shall be tested after completion of the core assembly to ensure that they withstand a voltage of 2 kV r.m.s with respect to core for duration of 60 seconds.

6.4.5 The transformer is required to be continuously in service, preferably without requiring any attention from the date of its Energisation, up to the periodical overhaul (POH), which is generally done after 10-12 years of service. The successful bidder/ manufacturer of the transformer shall take this aspect into account during core assembly/manufacture and indicate measures taken by them to ensure suitable clamping to permit the above frequency and cover this in their instruction manual.

6.5 Winding

6.5.1 The winding shall be of disc/concentric/interleave/multilayer type. The winding shall be uniformly insulated. The two outer terminals of the winding shall be brought out through 54 kV OIP condenser bushings whereas the neutral terminal (Centre tapping) through a 12 kV oil-filled porcelain bushing. The QAP of the manufacturing process is to be submitted along with the bid.

6.5.2 The winding shall be made of continuous electrolytic copper conductor, paper insulated to class-A Insulation. The conductor shall not have sharp edges which may damage the Insulation.

6.5.3 The workmanship shall be of high quality in keeping with Good Engineering Practices.

6.5.4 No joint shall be used in the winding conductor, in principle, except for inter-leave joint.

6.5.5 The transformer winding shall be designed for the following rated withstand voltages:

1	Rated short duration power frequency withstands voltage kV	95
2	Rated lightning impulse withstand voltage kV peak	250

6.5.6 The axial pre-compression on the winding shall preferably be double the calculated axial thrust that may be set up under dead short-circuit condition, so as to ensure that the winding do not become loose due to frequent short circuits in service.

6.5.7 During short circuits the stresses set up in conductors, spacers and blocks, clamping rings and such other parts of the transformer, shall not exceed one third of the maximum permissible values.

6.5.8 Pre-compressed spacers shall be used between disc shaped coils of the winding to transmit the axial forces generated due to the short circuits.

6.5.9 Wood Insulation, if used on the core and winding shall be seasoned, dried and well compressed and shall have adequate strength.

6.5.10 A uniform shrinkage shall be ensured during the drying of the individual coils or assembly of coils by providing a uniform clamping force with the help of hydraulic jacks or similar devices.

6.5.11 The separate winding compression structure shall be provided apart from the core clamping structure in order not causing any loose. The equal-axial force and continuous compression system shall be applied onto each assembled windings throughout the drying process and fixed with the high-tension, self-tightening structure to eliminate any loose, unbalanced force due to non-uniform shrinkage of windings. No re-tightening of winding after the production is prohibited.

6.5.12 The successful bidder / manufacturer shall furnish details of various stages of drying of coils, coil assembly up to and including oil impregnation and final tightening of the coil assembly, values of pressure, duration, temperature and degree of vacuum maintained at various stages of drying shall also be indicated.

6.5.13 To prevent displacement of the radial spacers used in the winding, closed slots shall be provided and a vertical locking strip shall be passed through these slots.

6.5.14 The vertical locking strips and slots of the radial spacers shall be so designed as to withstand the forces generated due to short circuits.

6.5.15 The vertical locking strips and radial spacers shall be made of pre-compressed pressboard conforming to grade PSP: 3052 of DIN 7733.

6.5.16 To prevent end blocks from shifting, pre-compressed pressboard ring shall be provided in between the two adjacent blocks. Coil clamping rings made of densified wood or mild steel shall be located in position with pressure screws.

6.5.17 Leads from the winding to the terminals and other interconnections shall be properly supported and secured.

6.5.18 The following particulars / documents in respect of the radial spacer blocks (winding blocks), vertical locking strips (axial ribs), end blocks, insulating cylinder, angle rings, paper Insulation of the conductor and coil clamping plates used in the manufacture of winding shall be furnished:

a) Reference to specification and grade of material.

b) Source(s) of supply.

c) Test certificates.

7 INSULATING OIL

7.1 The transformer shall be supplied with new inhibited mineral insulating oil conforming to IEC 60296. In addition, 10% extra oil by volume, shall be supplied in nonreturnable steel drums. The characteristics of the insulating oil before Energisation of service shall conform to IEC60296.

8 BUSHINGS AND TERMINAL CONNECTORS

8.1 Both the line and neutral bushings shall confirm to IEC 60137. On the line side, 54 kV class, sealed solid stem type Oil Impregnated Paper (OIP) condenser bushings shall be used. On the neutral side, 12 kV class oil-filed porcelain bushing shall be used. The dimensions of the bushings shall confirm to IEC 60137.

8.2 The OIP condenser bushings shall have a non-breathing oil expansion chamber. The expansion chamber shall be provided with an oil-level indicator, which shall be so designed and dimensioned that oil level is clearly visible from ground level. A test tap shall be provided for dielectric or power factor measurement.

8.3 The bushings shall be designed for the following Insulation level:

1	Highest voltage for equipment Um, kV	52	12
2	Rated short duration wet power frequency withstand voltage, kV	95	28
3	Rated lightning impulse withstand voltage, kV peak	250	75

8.4 The design and construction of the bushing shall be such that stresses due to expansion and construction in any part of the bushings shall not lead to its deterioration / breakage. The bushings shall be free from corona and shall not cause radio interference.

8.4.1 Adjustable arcing horns shall be provided on both the line and neutral bushings. The horn gap setting shall be variable as indicated below:

1	Highest voltage for equipment Um, kV	52	12
2	Horn gap setting variable between, mm	150 & 500	60 & 100

8.5 The bushing terminals shall be provided with rigid type terminal connectors of bimetallic type and shall be such that there is no hot spot formation even during the extreme over load condition of ONAN rating with 200% over loading.

8.6 The terminal connectors shall confirm to IS: 5561. The design shall as to be connected to the equipment terminal stud with a minimum of four 12 mm diameter bolts, nuts, spring and flat washers.

9 BUSHING TYPE CURENT TRANSFORMERS

9.1 The neutral bushing shall be so arranged as to accommodate bushing type current transformer (BCT) for connection to the AT neutral current ratio type fault locator as required as per the design. The BCT shall conform to IEC 60044-1 and meet with the stipulations in Clause 5.1(19) of this document.

9.2 The BCT shall be so designed as to withstand thermal and technical stresses resulting from frequent short circuits experienced by the transformer on which these are fitted.

9.3 Apart from the BCTs required for the biased differential protection, BCT of accuracy class 5 and conforming to IEC 60044-1, with suitable tappings, shall be mounted inside a line bushing for use with the winding temperature indicator.

9.4 The BCTs and the bushings shall be so mounted that removal of a bushing can be achieved without disturbing the current transformers, terminals and connections or pipe work is easy and convenient.

9.5 The leads from the BCTs shall be terminated in terminal boxes provided on the bushing turrets. Suitable links shall be provided in the terminal boxes for shorting the secondary terminals of the BCTs, when not connected to the external measuring circuits.

9.6 The leads from the secondary winding of the BCTs terminated in the terminal box on the bushing turret up to the marshaling box shall be of 1100V grade PVC insulated PVC sheathed, steel wire armored, stranded copper cable of cross-section not less than 4 mm^2 to IEC 60502-1.

9.7 Cable glands of proper size shall be provided in the terminal boxes to lead in / lead out the cables.

10 CLEARANCES

10.1 The relative orientation in space of the bushings fitted with terminal connectors, the main tank radiators, conservator, pressure relief device, oil piping and other parts when mounted on the transformer, shall be such that the various clearances in air from live parts of bushing shall not be less than the appropriate values given hereunder:

1	Highest voltage for equipment Um, kV	52	12
2	Minimum clearance, mm	500	200

The same distance shall apply for clearance of phase-to-earth (including oil piping work, conservator, pressure relief device and such other parts), phase-to-phase and towards terminals of a lower voltage winding.

11 COOLING EQUIPMENT

11.1 The transformer shall be designed for ONAN type of cooling.

11.2 The radiators shall consist of a pressed steel plate assembly formed into elliptical oil channels or a series of separate elliptical tubes. The radiators shall be designed in such a manner that the temperature-rise limits specified under Clause 5.1(11) of this document are not exceeded.

11.3 The radiators shall be removable (after isolating the same from the main tank) to facilitate transportation of the transformer. A drain plug of size 19 mm and an air-release plug of size 19 mm shall be provided at the bottom and at the top of each radiator bank for draining and filling of oil respectively. Each radiator bank shall also be provided with shut-off valves. If radiators are supplied as a separate unit then body bellows type flexible joints shall be provided on the oil headers.

11.4 The radiators shall preferably be supported directly on the transformer tank. Each radiator bank shall be fitted with lifting lugs.

12 PARTS, FITTINGS AND ACESSORIES

12.1 Apart from the parts, fittings and accessories specifically detailed in the foregoing Clauses, the parts, fittings and accessories detailed hereunder shall be supplied with each transformer:

12.1.1 **Oil level gauge**: It shall be of magnetic type having a dial diameter of 200 to 250 mm. The gauge shall have markings corresponding to minimum oil level, maximum oil level and oil level corresponding to oil temperature of 30^0C, 45^0C and 85^0C. The oil level indicator shall be so designed and mounted that the oil level is clearly visible to an operator standing on the ground. The oil level gauge shall be fitted with two SCADA readable contacts. The first contact shall provide a warning that the oil level is at 25% above the minimum level. The second contact shall indicate when the minimum oil level has been reached.

12.1.2 **Silica Gel Breather:** Auto-transformers shall be provided with Silica Gel Breather or N2 filled without Silica Gel Breather (in case of non-breathing design).If Silica Gel breather is provided; it shall be complete with oil seal and connecting pipes. The connecting pipes shall be secured properly. The container of the silica gel breather shall be of transparent flexi glass or similar material suitable for outdoor application.

12.1.2.1 Orange silica gel (round balls 2 to 5 mm) with quantity of two DT-8 silica gel connecting with flanged mounting two pipes control through different valves as per DIN: 42567 & IS: 6401 to be provided.

12.1.3 **Pressure relief device**: It shall be designed to operate to release internal pressure at preset value without and endangering the equipment is operator and shall be of instantaneous reset type.

12.1.3.1 Shroud Pressure Relief Device will be used and have provision of discharge of oil from PRD to safe place by closed pipeline to avoid hazards of fire.

12.1.4 **Filter valves**: The bottom and upper filter valves shall be of 50 mm size and suitably baffled to reduce aeration of oil. The valves shall be flanged to seat 40 mm adopter threaded to thread size P 1½ for connection to oil filtration plant.

12.1.5 **Drain valve**: It shall be of size 80 mm fitted with an oil sampling device of size 15 mm.

12.1.6 **Earthing terminals**: Two earthing terminals of adequate size shall be provided on the tank for its earthing with the help of 3 mild steel flats, each of size 50 mm x 6 mm. The terminals shall be clearly marked for earthing.

12.1.7 **Oil temperature indicator (OTI)**: It shall have one alarm contact, one trip contact and two normally open spare contacts none of the contacts being earthed. The contacts shall be electrically independent.

12.1.8 **Winding temperature indicator (WTI)**: It shall have one alarm contact, one trip contact and two normally open spare contacts, none of the contacts being earthed. The contacts shall be electrically independent. The windings shall also be fitted with analogue temperature sensors/thermistors/optical sensors that are suitable for being remote read via the SCADA system.

12.1.9 **Thermometer pockets**: A separate thermometer pocket with cap shall be provided on the tank for measuring the top oil temperature in the tank. The thermometer shall indicate hot spot temperature.

12.1.10 **Rating plate**: The rating plate shall indicate the following:

- The ratings of the transformer
- The connection diagram of the windings
- The particulars of the bushing current transformers
- Weight without oil
- Weight with oil
- Kind of transformer (I.e. Scott Connected traction transformer)
- Manufacturer
- Date of manufacture
- Serial number
- Rated Voltages in (kV) and tapping range
- Rated primary and secondary currents
- Short circuit impedance
- Type of cooling

Other details as per IEC 60076-1. The rating plate shall be both in English and Hindi version.

12.2 All valves shall be of the double flange type and fitted with suitable blanking plates on the outer face of the exposed flange.

12.3 The capillary tubes for temperature indicators shall be able to withstand normal bending. They shall be supported properly without sharp or repeated bends or twists.

13 FASTENERS

13.1 All fasteners of 12 mm diameter and less exposed to atmosphere shall be of stainless steel

and those above 12 mm diameter shall preferably be of stainless steel or of mild steel hot dip galvanized to 610 g/m^2 of zinc. The material of the stainless steel fasteners shall confirm to IS: 1570 (Part-V) Grade O4Cr17Ni12Mo22 or equivalents.

14 PAINTING

14.1 Shot blasting / sand blasting shall be done on the transformer tank to remove all scales, rust and other residue, before applying the paint inside the tank. All steel surfaces which are in contact with insulating varnish. All steel surfaces exposed to weather shall be given, one primer coat of zinc chromate and two coats of grey anti-corrosion paint. The touch-up of gray paint shall be applied at site by, the manufacturer.

15 TESTING OF TRANSFORMER

15.1 General

15.1.1 The designs and Drawings together with the Quality Assurance Plan (QAP) shall be furnished to the Engineer, within the period stipulated in the contract.

Only after all the designs and Drawings as well as the QAP have been approved for prototype tests and a written advice given to that effect shall the successful bidder / manufacturer take up manufacture of the prototype of the transformer. It is to be clearly understood that any change or modification required by the above authorities to be done in the prototype shall be done expeditiously, notwithstanding approval having already been given for the designs and Drawings.

15.1.2 Prior to giving a call to the Engineer for inspection and testing of the prototype, the successful bidder/ manufacturer shall submit diagrams for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. In case any dispute or disagreement arises between the successful bidder/manufacturer and representative of the Engineer during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type tests, it shall be brought to the notice of the Employer, as the case may be, whose decision shall be final and binding. Only after the prototype transformer is completed and ready in each and every respect, shall the successful bidder/manufacturer give the actual call for inspection and testing.

15.1.3 The type tests shall be carried out on the prototype transformer at the works of the successful bidder/manufacturer or at a reputed testing laboratory in the presence of the representative of the Engineer in accordance with the relevant specifications and as modified or amplified by this document.

15.2 Tests during manufacture

15.2.1 Though the test described below shall form part of the type tests, the manufacturer shall carry out these tests on first and every unit during the process of manufacture and submit the test reports to the Engineer deputed for witnessing the routine tests:

a) Oil leakage test.

b) Vacuum test.

c) Pressure test.

d) Test for pressure relief devise.

e) Measurement of capacitance and tan-delta values.

15.2.1.1 **Oil leakage test**: The transformer with its radiators, conservator tank and other parts,

fittings and accessories completely assembled shall be tested for oil leakage by being filled with oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure corresponding to twice the normal static oil head or to the normal static oil head plus 35 kN/m^2 (0.35 kgf/cm^2), whichever is lower, the static oil head being measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 h, during which time no leakage shall occur.

15.2.1.2 **Vacuum test**: The transformer tank only shall be tested at a vacuum of 3.33 kN/m^2 (0.0333 kgf/cm^2) for 60 min. The permanent deflection of flat plates after release of vacuum shall not exceed the values specified below:

Horizontal length of flat plate	Permanent deflection. mm
up to and including 750 mm	5.0
751 mm to 1250 mm	6.5
1251 mm to 1750 mm	8.0
1751 mm to 2000 mm	9.5
2001 mm to 2250 mm	11.0
2251 mm to 2500 mm	12.5
2501 mm to 3000 mm	16.0
above 3000 mm	19.0

15.2.1.3 **Pressure test**: Every transformer tank, radiator and conservator tank shall be subjected to an air pressure corresponding to twice the normal static head of oil or to the normal static oil head pressure plus 35 kN/m^2 (0.35 kgf/cm^2), whichever is lower, as measured at the base of the tank. The pressure shall remain constant do 1 hour to indicate that there is no leakage.

15.2.1.4 **Test for pressure relief devise**: Every pressure relief device shall be subjected to gradually increasing oil pressure. It shall operate before the pressure reaches the test pressure specified in Clause 15.2.1.3 hereof and the value at which it has operated shall be recorded.

15.2.1.5 **Measurement of capacitance and tan-delta values**: The measurement of capacitance and tan-delta (dielectric loss factor) of the transformer windings shall be made by Schering Bridge.

15.3 Type Tests

15.3.1 The type tests shall be carried out on the prototype transformer at the works of the successful bidder/manufacturer or at any reputed laboratory in the presence of the representative of the Engineer and in accordance with the relevant specifications and as altered, amended or supplemented by this document. Amongst others, following shall constitute the type tests:

1. Temperature-rise test.
2. Lightning impulse test.
3. Test with lightning impulse, chopped on the tail.
4. Short-circuit test.
5. Measurement of acoustic sound level.
6. Measurement of partial discharge quantity.
7. Measurement of harmonics of no-load current.

15.3.2 Temperature-rise test

15.3.2.1 The temperature-rise test shall be done in accordance IEC 60076-2 except as modified hereunder.

1	At rated load
2	At 150% rated load for 15min after continuous operation at rated load for 1hr.

3	At 200% rated load for 5min after continuous operation at rated load for 1hr.

The tests shall be done continuously without any power supply interruption. In case interruptions of power supply to take place for some reason, then the entire rest shall be repeated after steady state condition are attained.

15.3.2.2 The points to be ensured during the temperature-rise test shall be:

1	The ambient temperature shall be measured using calibrated thermometers only
2	The winding temperature shall be determined by the resistance method only.
3	The temperature of the top oil shall be measured calibrated thermometer placed in an oil-filled thermometer pocket.
4	The average oil temperature shall be calculated as the difference between the top oil temperature and half the temperature drop in the cooling equipment (radiators)
5	The temperature of the hot-spot in the winding shall be the sum of the temperature of the top oil and 'H' times the temperature rise of the winding above the average oil temperature, where 'H' is the hot spot factor as per IEC 600076-2 and 60076-7.

15.3.2.3 The test shall be carried out as described below:

15.3.2.3.1 **100% load**

1	A quantum of power equal to the sum of the measured losses viz. no-load and load losses corrected to 75^0C plus 10% of such sum shall be fed to primary winding of the transformer with the secondary winding short-circuited.
2	The power so fed to the transformer shall be continuously maintained till such time as the steady stats temperature is reached i.e. the top oil temperature rise does not vary by more than 1^0C during four consecutive hourly readings
3	On attaining the steady state temperature, the current in the primary winding of the transformer shall be brought to the rated current which shall be maintained for 1 hour. At the end of the period the power supply to the transformer shall be switched of and the time of Switching off recorded
4	The measurement of hot resistance shall commence as soon as is possible after switching off. The first reading of the resistance shall be taken as soon as possible, before expiry of 90 seconds from the instant of switching off and the first ten readings shall be taken at intervals of l5s apart. Thereafter, another ten readings shall be taken at intervals of 30s apart.
5	The time at which each of the resistance values is read shall also be recorded.
6	The temperatures of the ambient, top oil, the top and bottom radiator header oils shall also be recorded at half-hourly intervals throughout the test starting from the instant power supply is; switched on to commence the if test till it is switched off.
7	The WTI and OTI readings shall also be recorded at half hourly intervals right from the instant the power supply is switched on to commence the test till it is switched off
8	After power supply is switched off the readings of OTI and WTI shall be recorded at intervals of 1 min apart for 30 min

15.3.2.3.2 **150% load**

1	After completion, of the test at 100% load, the transformer shall be fed with power which shall be a value so as to cause circulation of the rated current in the primary winding with secondary windings short circuited. This current shall be circulated for 1 hour.
2	The current shall thereafter be increased to 150% of the rated current and maintained-for a period of 15 min. At the end of the 15 min period, the power supply shall be switched off and the time of switching off recorded.
3	Thereafter, the readings as indicated in Clause 15.3.2.3.1(4) to (8) shall be recorded.

4	The temperatures of ambient, top oil, the top & bottom radiator header oil and the temperatures indicated by OTI and WTI shall also be recorded at the time of switching on 150% load as well as at the time of switching off the power supply.

15.3.2.3.3 **200% load**

1	After completion of the test at 150% load, the transformer shall be fed with power which shall be a value so as to cause circulation of rated current in the primary with the secondary windings short circuited. This current shall be circulated for 1 hour.
2	The current shall thereafter be increased to 200% of the rated current and be maintained for 5minute period. At the end of the 5 minute period the power supply shall be switched off and the time of switching off recorded.
3	Thereafter, the readings as indicated in clause 15.3.2.3.1(4) to (8) shall be recorded.
4	The temperatures of ambient, top-oil, top & bottom radiator header oils and temperatures indicated by OTI and WTI shall also be recorded at the time of switching on the 200% load as well as the time of switching of the power supply.

15.3.2.3 **Determination of thermal time constant of the winding**: The thermal time constant of the winding under both rated load and overloads shall be verified during the temperature-rise tests.

15.3.2.4 The temperature rise of the oil, winding and current carrying parts in air under both the overload conditions stipulated in Clauses 15.3.2.3.2 and 15.3.2.3.3 above shall not exceed the values stipulated in Clause 5.1(11), of this document. The winding hot-spot temperature under the overload conditions shall not exceed 115^0C.

15.3.2.5 **Testing and calibration of the temperature indicators**: The functioning of the OTI and WTI shall be verified during the tests described above. Both the OTI and WTI shall be recalibrated, if necessary, to reflect the respective temperatures correctly. In particular, the reading of the WTI shall be the same as the calculated value of the hot-spot temperature of the winding.

15.3.2.6 **Determination of the thermal time constant of the WTI**: The thermal time constant of the WTI shall be determined for comparison with the thermal time constant of the winding of the transformer with respect to the transformer oil. For this purpose, the indications of the WTI and the OTI shall be recorded every 1 or 2 min during the first 1 h from the instant the transformer is loaded. From the slope of the curve plotted with the time on the X-axis and the difference between the readings of the WTI and OTI at the particular time on the Y-axis, the thermal time constant of the WTI shall be determined.

15.3.3 Lightning impulse test

15.3.3.1 This test shall be done in accordance with IEC 60076-3. The line and neutral terminals of the winding shall be tested with the following:

1	Highest voltage for Equipment Um, kV	52	12
2	Lightning impulse withstand voltage kV peak	250	75

15.3.4 Test with lightning impulse, shopped on the tail

15.3.4.1 This test shall be done in accordance with IEC 60076-3 with the appropriate test voltage as stipulated in Clause 15.3.3.1 above

15.3.5 Short-Circuit Test

The short-circuit test shall be conducted in accordance with IEC60076-5 with the following schedule:

15.3.5.1 Prior to commencement of the test, the following measurements/ tests shall be made:

a) Insulation resistance of the winding with respect to the earth.

b) No-load current.

c) No-load loss.

d) Resistance of windings.

e) Percentage impedance voltage.

f) Load loss.

g) Voltage ratio.

h) Di-electric tests comprising :

- Separate – source voltage withstand test, and
- Induced overvoltage withstand test.

i) Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18.

15.3.5.2 The test will be done with secondary side short-circuited and energizing the primary side of the transformer at its rate voltage.

15.3.5.3 The transformer shall be subjected to a total of seven shots in the following sequence:

1st Shot	Symmetrical current
2nd Shot	Asymmetrical current
3rd Shot	Asymmetrical current
4th Shot	Symmetrical current
5th Shot	Symmetrical current
6th Shot	Asymmetrical current
7th Shot	Symmetrical current

15.3.5.4 The duration of each shot shall be 0.5s.

15.3.5.5 Measurement shall be done after each shot for the following:

1	Percentage impedance voltage
2	No-load current
3	No-load loss

15.3.5.6 Further testing and inspection of the transformer subjected to the short-circuit test shall be carried out as per IEC 60076-5 with the modification that:

1	The dielectric routine tests shall be at 100% of the original test value
2	The percentage impedance voltages measured after the short circuit test shall not vary by more than 2% from those measured before the sort circuit test.

15.3.5.7 On completion of the short-circuit test the transformer shall be un-tanked for inspection of the core and windings. In case the inspection of the core and winding do not reveal any apparent defects and the results of the short-circuit test, the values of percentage impedance voltage as also the results of the routine tests done after the short-circuit test are in order, the transformer shall be deemed to have passed the short-circuit test.

If any of the results of the tests are not in order or the inspection of core and windings reveals any defect, then the transformer shall necessarily have to be dismantled completely for detailed inspection.

15.3.6 Measurement of acoustic sound level

15.3.6.1 Measurement of acoustic sound level of the transformer energized at rated voltage and frequency shall be carried out either as per IEC 60076-10.

15.3.7 Measurement of Partial discharge quantity

15.3.7.1 Partial discharge quantity of the windings shall be measured in accordance with IEC 60076-3.

15.3.8 Measurement of harmonics of no-load current

15.3.8.1 The magnitude of harmonics of no-load current as expressed in percentage of the fundamental shall be measured by means of a harmonic analyzer, in accordance with IEC 60076-1.

15.4 Type tests on part, fittings and accessories

15.4.1 Bushings

15.4.1.1 The type tests shall be carried out in accordance with IEC 60137 on porcelain housing of the bushings. The following shall constitute the type tests:

a) Visual inspection.

b) Verification of dimensions

c) Electrical routine test.

d) Porosity test.

e) Temperature cycle test.

f) Bending test.

15.4.1.2 The type tests shall be carried out in accordance with IEC 60137 on the prototype of the bushings. The following shall constituted the type test:

a) Wet power frequency withstand voltage test.

b) Dry lightning impulse voltage withstand test.

c) Thermal stability test.

d) Temperature-rise test.

e) Thermal short time current withstand test.

f) Dynamic current withstand test.

g) Cantilever load withstand test.

h) Tightness test.

i) Test of tap Insulation.

j) Tightness test at flange or other fixing device.

k) Measurement of partial discharge quantity.

15.4.2 Bushing type current transformers

15.4.2.1 The bushing type current transformers shall be tested in accordance with IEC60044-1.

15.4.3 Terminal connectors

15.4.3.1 The terminal connectors shall be tested in accordance with IS: 5561.

15.4.4 Temperature indicators

15.4.4.1 The following tests shall be conducted in prototypes of OTI and WTI:

1	Accuracy with reference to a standard instrument
2	Calibration of the indicators to reflect the actual temperature of the oil/ windings
3	Dielectric test at 2.5kV for 60s.
4	Vibration test.
5	Dust and water splash test to IP 55 degree of protection.

15.4.5 Pressure relief device

15.4.5.1 The following tests shall be conducted on the prototype of pressure relief device:

a) Air pressure test.

b) Leakage test.

c) Contact rating and operation test.

d) Dielectric test on contacts at 2.5kV for 60 s.

15.4.6 Radiators

15.4.6.1 The radiators shall be tested for air leakage at a pressure of 2.5 kg/m^2. The pressure shall remain constant for 1 h to indicate that there is no leakage.

15.5 Insulating oil

15.5.1 The following tests shall be carried out in accordance with IEC 60296 on the sample of new insulating oil for use in the prototype transformer

a) Density at 27^0C

b) Kinematic viscosity at 27^0C

c) Interfacial tension at 27^0C

d) Flash point.

e) Neutralization value (acidity)

f) Electric strength (with 2.5 mm gap)

g) Dielectric dissipation factor (tan-delta)

h) Specific resistance at 27^0C and at 90^0C

i) Oxidation stability

j) Water content

15.6 Routine tests

15.6.1 The following routine tests shall be performed on each transformer including the prototype unit in accordance with IEC 60076-1:

a) Visual examination

b) Insulation resistance test

c) Measurement of no-load current

d) Measurement of no-load loss

e) Measurement of resistance of the windings

f) Measurement of percentage impedance voltage

g) Measurement of load loss

h) Voltage ratio test

i) Dielectric tests comprising

- Separate-source voltage withstand test, and
- Induced overvoltage withstand test

j) Recording of SFRA as per IEC 60076.

15.6.2 Visual examination: A general examination shall be made to check that the transformer

conforms to the approved Drawings, various items are accessible for maintenance, the quality of workmanship and finish are of acceptable standards and all parts, fittings and accessories are provided.

15.6.3 **Insulation resistance test**: The Insulation resistance of the winding with respect to the earth shall be measured using a 5 kV Megger.

15.6.4 **Measurement of no-load current**: Measurement of no-load current referred to the primary side shall be done at 90%, 100%, and 110% of the rated voltage.

15.6.5 **Measurement of no-load loss**: Measurement of no-load loss shall be done at 90%, 100% and 110% of the rated voltage.

15.6.6 **Measurement of resistance of windings**: The resistance of the windings between the line and neutral terminals shall be measured and computed at 75^0C.

15.6.7 **Measurement of percentage impedance voltage**: The percentage impedance voltage shall be measured at rated current and at ambient temperature and computed at 75^0C.

15.6.8 **Measurement of load loss**: Load loss at rated current shall be measured at ambient temperature and computed at 75^0C.

15.6.9 **Voltage ratio test**: The voltage ratio shall be measured.

15.6.10 **Dielectric tests**

15.6.10.1 **Induced overvoltage withstand test**: The test shall be done as per IEC 60076-3.

15.6.10.2 **Separate source voltage withstand test**: A test voltage of 28 kV shall be applied between the winding and tank.

15.6.11 Recording of Surge Frequency Response Analysis (SFRA) as per IEC 60076-18.

15.6.12 During the routine tests of any unit, if it is found that the sum of the measured losses (i.e. no-load and load losses) (corrected to 75^0C) exceeds the value defined in Clause 15.3.2.3.1, or if the no-load loss/ load loss at the principal tapping exceeds the maximum guaranteed value defined in Clause 5.1 (12), the transformer shall be rejected.

15.7 If the prototype of a transformer conforming to this document and rating has already been approved in connection with previous supplies to Indian Railways, fresh type testing may be waived at the discretion of the Employer, provided that no changes whatsoever in the design or materials used or the process of manufacture have been made. However, the Employer reserves the right to conduct type tests if he deems it necessary to do so in the light of experience gained from previous supplies.

15.8 Only after approval of the original tracings of Drawings incorporating changes, if any, as a result of the prototype tests and clear written approval of the results of. the tests on the prototype is communicated by the Engineer, to the successful bidder/manufacturer, shall he take up bulk manufacture of the transformer which shall be strictly with the same materials and process of manufacture as adopted for the prototype. In no circumstances shall materials other than those approved in -the design/Drawings and/or during the prototype testing be used for bulk manufacture-on the plea that they had been obtained prior to the approval of the prototype.

15.9 No charges are payable for type test and/ or routine tests.

15.10 Transformer before dispatch should be filled with Nitrogen / dry air and provided with a gauge clearly visible for monitoring the pressure inside the tank.

16 TECHNICAL DATA AND DRAWINGS

16.1 The contractor shall furnish particulars in the proforma, at clause 20 the Schedule of Guaranteed Performance Technical and Other Particulars (SOGP) for the transformer. The particulars shall be complete in all respects. If there is any entry like shall be furnished later or a blank us left against any items, the offer is not likely to be considered as the evaluation of the offer is rendered difficult and cannot be compared with other offers, if any.

16.2 The contractor shall furnish the following information:

16.2.1 **Calculations for**:

a) Temperature rise of winding at rated current.

b) Hot-spot temperature of the winding at 150% and 200% rated loads for 15 min and 5 min respectively.

c) Thermal withstand capacity of the windings for a short circuit of 5s duration.

d) Mechanical force in respect of the following as per IEEMA (Indian Electrical & Electronic Manufacturer's Association) formulas given in Annexure-3:

i) Hoop stress in primary and secondary windings.

ii) Compressive pressure in the radial spacers.

iii) Internal axial compressive force.

iv) Axial imbalance force.

v) Radial bursting force.

vi) Resistance to collapse.

vii) Bending stress on clamping ring and densified wood.

viii) Maximum allowable torque on pressure screws for coil clamping bolts at the time of tightening, if any

e) Flux density with the characteristic curve.

f) Maximum value of inrush current.

16.2.2 Drawings for:

a) Outline general arrangement Drawing giving complete details of the transformer

b) Arrangement of the core, winding and magnetic path

c) Magnetizing characteristic of CRGO sheet steel.

16.3 The successful bidder/manufacturer shall submit to the Engineer for approval the following detailed dimensioned Drawings as per Indian Railways standard in sizes of 210 mm x 297 mm or any integral multiples thereof:

a) Outline general arrangement of the transformer indicating plan, front elevation, side elevation, with all parts, fittings and accessories, electrical clearances as well as salient guaranteed particulars.

b) Internal arrangement of the transformer indicating line and neutral bushing lead connections core to core-clamp earthing, core-clamp to tank earthing, core-clamp to Core-base bolting, and the locking arrangement of the core & coil assembly with the tank.

c) Cross sectional view of the core and winding with material specifications and makes.

d) Details of the pressure screws/ oil, dash-pot/ coil clamping bolts or other devices and their location with materials specification.

e) Schematic view of the valves used on the transformer and the antitheft device so as to prevent theft of oil.

f) Transport outline dimensional diagram.

g) General arrangement of marshaling box indicating protection and control equipment.

h) Wiring diagram of marshaling box.

i) Schematic diagram of protection and control circuits in marshaling box with cable schedule.

j) Legend plate showing protection and control circuits for fitment in the marshaling box.

k) OIP condenser bushing for line terminal including cross-sectional view, shed profile and salient electrical and mechanical characteristics.

l) Oil-filled porcelain bushing for neutral terminal including cross-sectional view shed profile and salient. Electrical and mechanical characteristics

m) Dimensional Drawing, V-I characteristics and rating plate for bushing type current transformers.

n) Rigid type terminal connector for line bushing terminal.

o) Rigid type terminal connector for neutral bushing terminal.

p) Rating plate with diagram of connections both in English and Hindi versions.

q) Details of radiator

r) Details of breather.

s) External cables run with cable schedule.

t) Any other Drawings considered necessary by the successful bidder/ manufacturer and / or Employer.

16.3.1 After approval, six copies of each of the approved Drawings along with two sets of reproducible prints for each Drawing shall be supplied.

16.3.2 Two copies of the “Operations and Maintenance manual” shall be supplied.

17 CAPITALISATION OF TRANSFORMER LOSSES (Not applicable)

17.1 (Deleted).

18 SPARES

The bidder shall quote separately for the following essential spares for every lot of up to 5 transformers or part thereof:

a) One line bushing complete with parts, fittings and bushing type current transformer.

b) One neutral bushing complete with parts, fittings and bushing type current transformer.

c) One complete set of gaskets of all sizes required for use in the transformer.

d) One piece of radiator.

e) One terminal connector each for line and neutral side bushing terminals.

f) One set valves.

g) One pressure relief device.

19 ERECTION TESTING AND COMMISSIONING

19.1 The transformer shall be erected and commissioned by the Contractor. The successful bidder shall invariably make available at site the services of qualified personnel to ensure, by his continued presence, that the process of erection, testing and commissioning of the transformer

is in accordance with established recommended practices. For this purpose prior intimation regarding the dates/period and locations at which the transformers are to be erected and testing/commissioning done shall be given by the Engineer to the successful bidder. No charges shall be payable by the employer to the successful bidder/manufacturer for the services of his engineer in this regard.

20 SCHEDULE OF GUARANTEED PERFORMANCE, TECHNICAL AND OTHER PARTICULARS (GUARANTEED PARTICULARS ARE TO BE ESTABLISHED BY ACTUAL TESTS/ TEST REPORTS)

SN		DESCRIPTION	UNIT OF MEASUREMENT	VALUE/ INFORMATION
1		2	3	4
A		**RATINGS/PARTICULARS**		
1.		Name of the Manufacturer		
2.		Country of manufacture		
3.		Reference to specification based on which performance data is prescribed		
4.		Rated power	MVA	
5.		Primary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
6.		Secondary current at:		
		a) Rated load	A	
		b) 150% rated load for 15 min	A	
		c) 200% rated load for 5 min	A	
7.		Rated voltage :		
		a) Primary	kV	
		b) Secondary (at no-load)	kV	
8.		Rated frequency	Hz	
9.		Temperature rise above ambient temperature of 50 ^{0}C :		
	(i).	Oil :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
	(ii)	Winding :		
		a) At rated load	^{0}C	
		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
10		Hot-spot temperature of winding over ambient temperature of 50^0 C	^{0}C	
		a) At rated load	^{0}C	

		b) At 150% rated load for 15 min.	^{0}C	
		c) At 200% rated load for 5 min	^{0}C	
		Interval of time between two successive overloads after continuous working at full load, at maximum ambient temperature of 50°C:		
		a) Between two consecutive over loads of 50% for 15 min	min.	
		b) Between two consecutive min overloads of which one is of 50% for 15 min and the other of 100% for 5 min.	min.	
11		No-load current referred to primary side at rated frequency and at:		
		a) 90% rated voltage A		
		b) Rated voltage A		
		c) 110% rated voltage A		
12		Power factor of no-load current at rated voltage and rated frequency		
13		Value of the inrush current at rated voltage on primary side, the secondary side being open circuited		
14		Losses:		
	(i)	No-load loss at rated frequency and at:		
		a) 90% rated voltage	kW	
		b) rated voltage.	kW	
		c) 110% rated voltage.	kW	
	(ii)	Load loss (at 75 ^{0}C) at rated current and frequency	kW	
	(iii)	Total losses at rated current and frequency		
15		Resistance voltage (at 75 ^{0}C) at rated current	%	
16		Reactance voltage (at 75 ^{0}C) at rated current and frequency	%	
17		Impedance voltage (at 75 ^{0}C) at rated current and frequency	%	
18		Resistance (at 75 ^{0}C) of primary winding	Ohm	
19		Resistance (at 75 ^{0}C) of secondary winding	Ohm	
20		Reactance of winding :	H	
	i)	Primary	H	
	ii)	Secondary at	H	
21		Regulation (at 75 ^{0}C) with rated current and at power factor of:		
		a) Unity	%	
		b) 0.8 lagging	%	
22		Efficiencies:		
	(i).	Efficiency (at 75 ^{0}C) at unity power factor at:		
		a). 100% load	%	
		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(ii).	Efficiency (at 75^{0}C) at 0.8 power factor lagging at:		
		a). 100% load	%	

		b). 75% load	%	
		c). 50% load	%	
		d). 25% load	%	
	(iii)	Percentage of rated load at which maximum efficiency occurs.	%	
23		Ability to withstand short-circuit:		
		a). Thermal	S	
		b). Dynamic	S	
24		Thermal time constant (calculated):		
	(i)	for winding with respect to oil at:		
		a). rated current	Min	
		b). 150% rated current	Min	
		c). 200% rated current	Min	
	(ii)	Complete transformer at rated current	Min	
25		Temperature gradient between oil and winding at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min.	^{0}C	
26		Temperature rise of oil:		
	(i).	Calculated average temperature rise of oil at:		
		a). Rated current	^{0}C	
		b). 150% rated current for 15 min	^{0}C	
		c). 200% rated current for 5 min	^{0}C	
	(ii)	Estimated temperature rise of top oil at:		
		a). Rated current ^{0}C		
		b). 150% rated current for 15 min ^{0}C		
		c). 200% rated current for 5 min ^{0}C		
27		Details of core:		
	(i)	Type of core		
	(ii)	Flux density at rated voltage and frequency	Tesla	
	(iii)	Flux density at 110% rated voltage and frequency	Tesla	
	(iv)	Thickness of steel stampings	Mm	
	(v)	Grade of core material and conforming specification		
	(vi)	Exciting VA/kg for core stampings at:		
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	VA/kg	
	(vii)	Exciting VA/kg for assembled core at:		
		a) Flux density of 1.55 tesla	VA/kg	
		b) Flux density at rated voltage	VA/kg	
		c) Flux density at 110% rated voltage	Va/kg	
	(viii)	Type of Insulation between core laminations.		

	(ix)	Type of joint between the core limbs and yoke.	kV	
	(x)	Core bolt Insulation withstand voltage	kV	
	(xi)	Core bolt Insulation flashover voltage	kV	
28		Details of windings:		
	(i)	Type of winding		
		(a) Primary		
		(b) Secondary		
		(c) Number of turns of primary winding		
		(d) Number of turns of secondary winding		
		(e) Number of parallel paths in primary winding		
		(f) Number of parallel paths in secondary winding.		
		(g) Is interleaving/inter shielding of the winding adopted to ensure better impulse voltage distribution?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(h) Is the Insulation of end turns of winding reinforced?	Yes/No	
		(i) Primary		
		(ii) Secondary		
		(i) Type of coil		
	(ii)	Mode of connection (i.e. in series or in parallel) of the portions of the windings on the two limbs of the core, if applicable.		
	(iii)	Dimensions of the copper conductor used in the winding:		
		a) Primary	mm x mm	
		b) Secondary	mm x mm	
		c) Tapped winding.	mm x mm	
	(iv)	Current density at rated current.		
		a) Primary	A/mm^2	
		b) Secondary	A/mm^2	
	(v)	Insulation used over the conductor (details of material and specification there for)		
	(vi)	Type of joints, if any, in the windings		
	(vii)	Dielectric strength of windings:		
		a) Full wave lightning impulse withstand voltage:		
		i) Primary winding	kV peak	
		ii) Secondary winding.	kV peak	
		(b) Lightning Impulse chopped on the tail withstand voltage:	kV	
		(i) Primary winding		
		(ii) Secondary winding		
		(c) Separate source power frequency withstand voltage	kV	
		(i) Primary		

		(ii) Secondary		
		(d) Induced over voltage withstand value		
	(viii)	Minimum flashover distance to earth in oil of :		
		a) Secondary winding to core		
		b) Primary winding to yoke		
		c) Primary winding to tank		
	(ix)	Material used for coil clamping rings and specification there for		
	(x)	Magnitude of axial pre-compressive force on the winding		
		(a) Primary	kV peak	
		(b) Secondary	kV peak	
	(xi)	Calculated maximum axial thrust in the winding due to dead short circuit at the terminals		
		(a) Primary		
		(b) Secondary		
	(xii)	Calculated short circuit forces:		
		a) Hoop stress in primary winding	kgf/cm^2	
		b) Hoop stress in secondary winding	kgf/cm^2	
		c) Compressive pressure in the radial spacers		
		d) Internal axial compressive force	kgf/cm	
		e) Axial imbalance force		
		f) Resistance to college	Kgf	
		g) Bending stress on clamping	kgf/cm^2	
		h) Radial bursting force		
	(xiii)	Arrangement to maintain constant pressure on the windings		
	(xiv)	Maximum permissible torque on pressure screws for coil clamping at the time of tightening, if any.	N.m	
	(xv)	Can either end of each secondary winding (25 kV) be connected directly to earth?	Yes/No.	
29		Bushings:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation (specify as to whether it is OIP condenser bushing)		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV peak	

		i) Lightning impulse withstand voltage	mm	
		j) Creepage distance		
		k) Weight of assembled bushing	Kg	
	(ii)	Secondary side		
		a) Name of the manufacturer		
		b) Country of origin		
		c) Governing specification		
		d) Type designation		
		e) Voltage class	kV	
		f) Rated current	A	
		g) Visible power frequency discharge voltage	kV	
		h) Wet one minute power frequency withstand voltage	kV	
		i) Lightning impulse withstand voltage	kV peak	
		j) Creepage distance	mm	
		k) Weight of assembled bushing	kgf	
30		Bushing type current transformers:		
	(i).	Primary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ratio		
		d) Accuracy class and rated accuracy limit factor		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^{0}C	ohm	
		j) Short time thermal current and duration.	kA, s	
	(ii)	Secondary side:		
		a) Name of the manufacturer		
		b) Governing specification		
		c) Transformation ration		
		d) Accuracy class		
		e) Rated current	A	
		f) Rated output	VA	
		g) Exciting current at the rated knee point emf	mA	
		h) Rated knee point emf	V	
		i) Secondary winding resistance corrected to 75^{0}C.	ohm	
		j) Short time thermal current and duration	kA, s	
31		Insulating oil :		
		a) Governing specification		
		b) Grade of oil		
		c) Source of supply		
		d) Specific resistance at:		

		i) 27 ^{0}C	ohm-cm	
		ii) 90 ^{0}C	ohm-cm	
		e) Dielectric, dissipation factor (tan-delta) at 90 ^{0}C-		
		f) Dielectric strength	kV	
		g) Water content	ppm	
		h) Interfacial tension	N/m	
		i) Neutralisation value	mg KOH/gm	
		j) Flash point	°C	
32		Type of transformer tank		
33		Details of radiators:		
		a) Make and type		
		b) Type of mounting		
		c) Overall dimensions (LxWxH)	mmx mm x mm	
34		Details of Buchholz relay:		
		a) Make and type		
		b) Governing specification		
		c) Provision of shut-off valves on either side of the relay	Yes/No	
		d) Provision of alarm contact	Yes/No	
		e) Provision of trip contact	Yes/No	
		f) Rated current of contacts	A	
35		Details of winding temperature		
		Indicator.		
		a) Make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
36		Details of oil temperature indicator		
		a) make and type		
		b) Governing specification		
		c) Number of contacts provided		
		d) Rated current of contacts	A	
		e) Dielectric withstand value of contacts	kV	
37		Details of Magnetic oil level gauge:		
		a) Make and type		
		b) Governing specification		
		c) Diameter of dial mm		
		d) Number of contacts provided		
		e) Rated current of contact	A	

		f) Dielectric withstand value of contacts	kV	
38		Details of pressure relief device:		
		a) Make and type		
		b) Governing specification		
		c) Does it reset itself	Yes/No	
39		Bimetallic terminal connectors:		
	(i)	Primary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45°C while carrying rated current.	°C	
		f) Short time current and duration	kA, s	
	(ii).	Secondary side:		
		a) Source of supply		
		b) Governing specification		
		c) Type		
		d) Rated current	A	
		e) Temperature rise over an ambient temperature of 45^0C while current rated current	°C	
		f) Short time current and duration	kA, s	
40		Acoustic sound level at a distance dB of 1 m, when energised at rated voltage and rated frequency without load.		
41		Partial discharge value at 1.5Um/ 3 kV r.m.s.	pC	
42		Weights and dimensions:		
	(i)	Net weight of core		
	(ii)	Net weight of cooper:		
		a) Primary winding	kg	
		b) Secondary winding	kg	
	(iii)	Net untanking weight of core frame and coils	kg	
	(iv)	Net weight of insulating oil	kg	
	(v)	Volume of insulating oil	l	
	(vi)	Total weight of cooling equipment	t	
	(vii)	Total weight of transformer without oil	t	
	(viii)	Total shipping weight of complete transformer including all detachable parts, fittings and assemblies	t	
	(ix)	Shipping weight of largest package	t	
	(x)	Crane lift (excluding slings) for un-tanking core and coils	mm	
	(xi)	Crane lift (excluding slings) for removal of primary side bushings.	mm	
	(xii)	Dimensions of the complete transformer including all parts, fitting and accessories:		

		a) Overall length	mm	
		b) Overall breadth	mm	
		c) From rail level to the topmost point	mm	
	(xiii)	Minimum thickness of steel plate/ sheet used:		
		a) Bell tank mm		
		b) Tank bottom mm		
		c) Conservator mm		
		d) Radiator mm		
		e) Marshalling box. mm		
	(xiv)	Overall shipping dimensions of the largest package (Length x width x height)	mm x mm x mm	
	(xv)	Mode of transportation of transformer unit (filled with oil/nitrogen gas.)		
		Other particulars		
43		Is the transformer tank fitted with lifting pads? If yes, what is the number of pads	Yes/ No	
44		What is the number of inspection covers provided?		
45		Are comfits/ trays provided for cable run?	Yes/ No	
46		Is the core electrically connected with the tank?	Yes/No	
47		Will the gaskets to be used in the transformer give trouble free service for at least 7 years? If not, indicate the life.	Yes/No	
48		Is the core construction without core bolts?	Yes/No	
49		Are the core bolts grounded, and if so, how?	Yes/ No	
50		What is the number of radial spacers used in the winding?		
51		What is the number of joints provided in the winding?		
52		Are the spacers/blocks/angle rings of pre-compressed press boards? If no, indicate the material with specification.		
53		Are arrangements made for ensuring automatic constant pressure on the coils? If no. give the reasons.	Yes/ No	
54		Are closed slots provided on outer most winding for locking the vertical strips? If no, give the reason.	Yes/ No	
55		What is the periodicity for tightening of coil clamping arrangement?	Years	
56		What are the designed values of short-circuit current for:		
		a) Symmetrical :		
		i) Primary winding A		
		ii) Secondary winding A		
		b) A symmetrical:		
		i) Primary winding A		
		ii) Secondary winding A		
57		What is the over flux withstand capability of the transformer	Tesla	

		(Maximum permissible limit of flux density)?		
58		Are windings pre-shrunk?	Yes/No	
59		Have the details of drying cycles of the coils/coil assembly including final tightening values of pressure, temperature and degree of vacuum at various stages of drying been furnished?	Yes/ No	
60		Are arcing horns provided for line and neutral bushings?	Yes/ No	
61		Is a test tap provided in the line bushing?	Yes/ No	
62		Is the porcelain housing of the bushings of single piece construction?	Yes/ No	
63		Is the shed profile of porcelain housing of the bushing free from under-ribs but has a lip?	Yes/ No	
64		Is the bushing type current transformer of low reactance type?	Yes/ No	
65		Is Clause by Clause "Statement of compliance" attached?	Yes/ No	
69		Are fasteners of 12 mm diameter and less exposed to atmosphere of stainless steel to Grade 04Cr17 Ni12Mo to IS 1570 Part-V?	Yes/ No	
70		Are the fasteners of more than 12 mm diameter exposed to atmosphere of stainless steel or MS hot dip galvanized?	Yes/ No	
71		Are test certificates for tests as per Clause 15.0 attached?	Yes/ No	
72		Are all the calculations required as per clause 16 enclosed.	Yes/ No	
73		Are all the Drawings required as per clause 16.3.2 attached?	Yes/ No	
74		(a) Are all the parts, fittings and accessories from Employer's approved manufacturers?	Yes/ No	
		(b) If not, list the items which are to be type tested in the presence of Employer’s Personnel.	Yes/No	
75		Is adequate space provided in the marshaling box for housing the wiring and components?	Yes/ No	

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(Annexure – 1)

TECHNICAL SPECIFICATIONS FOR NITROGEN INJECTION FIRE PREVENTION AND EXTINGUISHING SYSTEM FOR OIL FILLED TRANSFORMER

1.0 GENERAL DESCRIPTION:

Nitrogen injection fire protection system designed for oil filled transformers shall prevent tank explosion and the fire during internal faults resulting in an arc, where tank explosion will normally take few seconds after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion and/or external failures like busing fires, OLTC fires and fire from surrounding equipment's.

The system shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and deduce the temperature of top oil surface below flash point to extinguish the fire.

Conservator tank oil shall be isolated during busing bursting, tank explosion and oil fire to prevent aggravation of fire.

Transformer isolation shall be an essential pre-condition for activating the system. The system shall be designed to operate automatically. However, it shall be designed for manual operation, in case of failure of power supply.

The system shall consist of following equipment:

1. Fire extinguishing cubicle placed on a plinth at about 5-10 meter away from the transformer.
2. Control box placed in the control room.
3. Necessary valves in the conservator pipe.
4. Suitable fire sensing components to be provided preferably in/on the tank cover.
5. Signal box suitably placed.

2.0 SCOPE

The scope of this document covers design, engineering, supply testing at works before dispatch; erection, testing and commissioning and performance demonstration of "fire protection and extinguishing system by nitrogen injection method".

The necessary civil work which will be required for construction of oil soak – pit for the storage of oil coming out from the transformer and plinth for extinguishing cubicle is outside the scope of this document. However, laying of oil pipe, nitrogen pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary vales, fire detectors and other equipments& accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the tenderer. It will be the responsibility of the tenderer, i.e. transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests. Notwithstanding the technical specifications and requirements mentioned herewith any modification can be incorporated for correct operation of nitrogen injection fire protection system without extra cost. The full details of the same are required to be submitted to Employer for approval, when first unit is implemented on a transformer of specific make & rating.

3.0 OPERATIONAL CONTROLS:

The system shall be provided with automatic control for fire prevention and fire extinction. Besides automatic control, remote electrical push button control on control box and local manual control in the fire-extinguishing cubicle shall be provided. The fire protection system will take signal from HV/LV circuit breaker.

4.0 SYSTEM ACTIVATING SIGNALS:

4.1 Transformer isolation shall be an essential pre-condition for activating the system. Provision shall be provided to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before Nitrogen injection and after oil depressurization.

4.2 There shall be two modes of operation of Fire Protection System i.e. Fire Prevention Mode & Fire Extinction Mode. In these mode the safety equipment to be involved are tabulated below. The logic of their operation shall be finalized during design approval.

Mode of Operation	Safety Equipment to be used
Fire Prevention Mode	• Differential relay/Over current/Restricted earth fault relay. • Pressure relief valve
Fire Extinction Mode	• Fire sensing components • Buchhloz relay

5.0 SYSTEM EQUIPMENT:

5.1 Fire Extinguishing Cubicle (FEC), placed on plinth at about minimum 5 meter away from the transformer shall consist of:

5.1.1 Nitrogen gas cylinder with pressure reducer/regulator and falling pressure electrical contact manometer.

5.1.2 Oil drain pipe with mechanical quick drain valve;

5.1.3 Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.

5.1.4 Pressure monitoring switch for backup protection, pressure reducer with solenoid valve in the cabinet for operation of nitrogen gas release, which will be IP-65, protected and leak proof for nitrogen release.

5.1.5 Limit switches for monitoring of the system.

5.1.6 Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.

5.1.7 Panel lighting

5.1.8 Oil drainpipe extension of suitable sizes for connecting pipes to oil pit.

5.1.9 The Nitrogen gas cylinder should be of sufficient (not less than 50 liter) capacity and should be filled at a pressure of not less than 150 bars with falling pressure electrical contact manometer, suitable design measures to prevent leakage of gas to be taken.

5.1.10 The nitrogen valve shall have IP-65 protection. The nitrogen shall be contained within the cylinder and released from the cylinder valve only upon activation of the fire protection system. Nitrogen purity shall 99.99%

5.1.11 Proper approvals and certificates should be provided with each cylinder. No used nitrogen bottle will be accepted.

5.2 Control box with activating, monitoring devices and line faults indicators to be placed in control room. It should have audiovisual alarm indication and push button switches for tests response.

5.3 Necessary valves to be fitted in the conservator pipeline between conservator and Buchholz relay operating mechanically on transformer oil flow rate with electrical signal for monitoring.

5.4 Suitable fire sensors to be fixed on transformer tank top cover and off circuit tap changer for sensing fire.

5.5 Signal box to be fixed on transformer side will for terminating cable connection from sensors and conservator shutter/signal box to be suitably placed.

5.6 All other consumables necessary for operation of complete system.

5.7 Control box should be microprocessor based and compatible to be interfaced with existing RTU for Railway Traction SCADA system available at the control room. For communication, Control box shall have provision for interfacing with SCADA in this regards details Digital Input & Output required for operation monitoring through SCADA should be furnished.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION:

6.1 Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.

6.2 Flanges with dummy piece in conservator pipe between Buchhloz relay and conservator tank for fixing.

6.3 Brackets on transformer top cover for sensing equipment, valves to enable operation of the system.

6.4 Spare potential free contacts for system activating signals i.e. differential relay, Buchholz relay, pressure relief valve, transformer isolation (master trip relay).

6.5 Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

6.6 Cabling on transformer top cover all sensors to be suitably connected for reliable fire sensing and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

6.7 Plinth for fire extinguishing cubicle. Oil pit with capacity as 10% of total oil quantity of transformer.

7.0 TECHNICAL DETAILS:

Fire extinction period:

On commencement of Nitrogen injection	:	Maximum 30 seconds
On system activation up to post cooling	:	Maximum 3 minutes
Heat sensing area	:	800 mm radius
Temperature for effective heat sensing	:	140± 2°C
Seating for operation to isolate conservator	:	Min.60 Ltr. per minute

Power Source:

Control Box	:	110 V DC
Fire extinguishing cubicle for lighting	:	240 V AC

8.0 CABLING:

8.1 Fire survival cables, able to withstand 750°C, 1.5 mm² with necessary no. of conductors for connection of fire detectors in parallel shall be used. The test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used.

8.3 Fire retardant low smoke (FRLS) cable 1.5 mm² with necessary no. of conductors for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/marshalling box to transformer shall be used.

9.0 PREVIOUS EXPERIENCE FOR QUALIFYING SUPPLIER:

The supplier shall have a minimum experience of two years in the design, manufacturing, erection, testing and commissioning of Nitrogen Injection Fire Protection System on power transformers of similar or higher rating. At least 2 sets of the system shall be in successful operation for a minimum period of the 2 years. The supplier shall furnish the details of Nitrogen Injection Fire Protection System supplied by them so far, giving order reference, name and address of the customer, indicating the dates of commissioning as well as performance certificate of successful and satisfactory operation for minimum two years from the customers.

10.0 TESTS

10.1 Type Tests

Type test reports including that for detectors along with declared response time as per test approval certificate letter shall be submitted along with the tender.The system shall be tested by international or a national testing body (NABL accredited recognized laboratory. Tariff Advisory Committee (TAC's) approval, if any, shall be submitted with the tender.

10.2 Factory Test

Tests will be carried out on individual equipment of the system and the total system in the supplier's workshop in presence of purchaser's representative.

10.3 Performance Test

Performance test of the complete system shall be carried out after complete erection at site by the supplier's representative. These tests shall include simulation and verification of the response of the complete system without actual draining of the oil and injection of the nitrogen gas.
In addition to above, additional tests as required necessary shall be conducted.

11.0 DRAWINGS AND MANUALS

Detailed layout drawing along with the equipment drawing to be given in the tender along with complete bill of materials. After awarding of contract, detailed dimensional drawing of the system complete bill of materials including location and size of plinth for cubicle and recommended capacity of oil soak-pit shall be submitted for purchaser's approval. After approval 10 (ten) sets of all above drawings and 5 (five) sets of operation and Maintenance Instruction Manual (bound) shall be submitted for purchaser's use.

12.0 SPARES:

One full set of spare nitrogen gas filled cylinder, one set of the installed no. of fire sensors shall be provided in addition to additional other recommended spares. The list of recommended spares is to be submitted along with the tender.

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BID DOCUMENT FOR

DESIGN, SUPPLY, CONSTRUCTION, INSTALLALTION, OF 2X25 kV ELECTRIFICATION, SIGNALLING & TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA – NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

SYSTEM WORKS CONTRACT PACKAGE

Issued on: 29.12.2017

Bid Document No.: HQ/SYS/EC/D-B/MGS-DGO & KWDN-CPBH-SEBN

(Part-3)

Conditions of Contract and Contract Forms

Employer:

DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LIMITED

A GOVERNMENT OF INDIA ENTERPRISE

under

MINISTRY OF RAILWAYS
INDIA

PART 3 – Conditions of Contract and Contract Forms

Contents

Section- VI
General Conditions
(GC)

Section VI. 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 -VII

Particular Conditions of Contract (PCC)

Section VII. 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 VI. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions.

Clause	PROVISIONS
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, Part 5 Bidding Document*
Sub-Clause 1.1.6.9	**Delete the existing clause and modified as under:** "Variation" means any change to the scope of works, design criteria and specifications, and criteria for the installation, testing and commissioning, particular specifications of the completed works specified in the Employer's Requirements.
Sub-Clause 1.2. Interpretation	**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 1.7 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, installation, testing and commissioning, particular specifications 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, testing and commissioning, Particular Specifications 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 and (if so) to what extent the error could not reasonably have been so

	discovered, and (ii) the matters described in sub-paragraphs (a) and (b) above related to this extent.
Sub- clause 1.14 Joint and Several Liability	**Delete Sub- clause (b) and replace with:** If the contractor constitutes (under applicable laws) a Joint Venture, etc, the following provisions will be applicable : (i) One of the members of the JV firm shall be its lead member who shall have majority (at least 51%) share of interest in the JV firm. The other members shall have a share of not less than 20% each in case of JV firms with upto 3 members and not less than 10% each in case of JV having more than three members. (ii) Joint And Several Liability - Members of the JV Firm to which the contract is awarded, shall be jointly and severally liable to the Employer (DFCCIL) for execution of the project in accordance with General and Special Conditions of Contract. The JV members shall also be liable jointly and severally for the loss, damages caused to the DFCCIL during the course of execution of the contract or due to non-execution of the contract or part thereof. (iii) Duration of the Joint Venture Agreement - shall be valid during the entire currency of the contract including the period of extension, if any and the defect liability period after the work is completed. (iv) Governing Laws - The Joint Venture Agreement shall in all respect be governed by and interpreted in accordance with Indian Laws. (v) Once the tender is submitted, the MOU shall not be modified / altered / terminated during the validity of the tender. In case the bidder fails to observe/comply with this stipulation, the full Bid Security Deposit/Earnest Money shall be liable to be forfeited. (vi) Approval for change of constitution of JV Firm shall be at the sole discretion of the Employer (DFCCIL). The constitution of the JV Firm shall not be allowed to be modified after submission of the tender by the JV Firm, except when modification becomes inevitable due to succession *laws* etc. and in any case the minimum eligibility criteria should not get vitiated. However, the Lead Member shall continue to be the Lead Member of the JV Firm. Failure to observe this requirement would render the offer invalid. (vii) Similarly, after, the contract is awarded, the constitution of JV Firm shall not be allowed to be altered during the currency of contract except when modification become inevitable due to succession laws etc. and in any case the minimum eligibility criteria should not get vitiated. Failure to observe this stipulation shall be deemed to be breach of contract with all consequential penal action as per contract conditions. (viii) On issue of LOA (Letter of Acceptance), an agreement among the members of the JV Firm (to whom the work has been

	awarded) shall be executed and got registered before the Registrar of the Companies under Companies Act or before the Registrar/Sub - Registrar under the Registration Act, 1908. This JV Agreement shall be submitted by the JV Firm to the DFCCIL before signing the contract agreement for the work. In case the tenderer fail to observe/comply with this stipulation, the full BID SECURITY shall be forfeited and other penal actions due shall be taken against partners of the JV and the JV. (ix) No member of the Joint Venture Firm shall have the right to assign or transfer the interest right or liability in the contract without the *written* consent of the other members and that of the employer (DFCCIL) in respect of the said tender*/contract.*
New Sub- clause 1.15 **Fraud & Corruption**	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

[1] "Another party" refers to a public official acting in relation to the procurement process or contract execution]. In this context, "public official" includes 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.

	evidence material to the investigation or making false statements to investigators in order to materially impede a 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
Sub- clause 2.1 **Right of Access to Site**	**Delete Sub- clause (b) in para 3 .** Add the word "**Formation, Track**" after the word plant in 5th line of Para 1.
Sub-Clause 3.1 **Engineer's Duties and Authorities**	**Add the following at the end of this Sub-Clause:** Notwithstanding anything contained hereinabove, the Engineer is required to obtain approval of the Employer before exercising specific authorities as listed below: i) giving consent to proposed Subcontractors pursuant to Sub-Clause 4.4 (b).; ii) giving consent to contractor's proposed designer under Sub-Clause 5.1 and giving approval to contractor's documents under Sub-Clause 5.2. iii) Clearance of concept design & drawings, and Yard Plans submitted by the Contractor for alignment and Works requiring sanction of Commissioner of Railway Safety; iv) Taking action in connection with variation in the Employers' requirement which has been initiated by the Employer. v) Carrying out testing as per sub clause 7.4. vi) Carrying out Tests on completion as per clause 9. vii) Employer's taking over of the works as per clause 10. viii) Issue of performance certificate as per sub clause 11.9. ix) Approving any extension of time for completion of work. x) Instructing or approving Variations pursuant to Sub-Clauses 13.1, 13.2 and 13.3; except in an emergency affecting the safety of life or of the works or of adjoining property or track, he may, without relieving the Contractor of any of his duties and responsibility 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 at the end of para 4(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 by 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 **Sub Contractors**	**Delete first line and substitute by the following:** The contractor shall not sub contract more than 30% of the total works. This is in addition to the activities of sub-contracting to specialized sub-contractors highlighted in para 3.1(b) and 3.2 of Section III Qualification Criteria and requirements. **Add the following at the end of the sub clause:** "The Employer at his discretion may permit the replacement of specialized sub contractors named in the contract provided new specialist sub-contractors have required qualification"
Sub-clause 4.7 **Setting Out**	**Delete paragraph 2,3 & 4 of Sub-clause 4.7 and substitute by 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**	**Paragraph 1 of Sub-Clause 4.10.** Add at the end of the paragraph Accordingly, the Contractor shall have no claim in this regard." **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 4.12 **Unforeseeable Physical Conditions**	**Delete the Sub-Clause and Substitute by 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** Any change in Control of the Contractor, or in case if the Contractor is a JV, any change of Control of any of the members of the JV, 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, 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/or beneficial ownership of more than 50% (fifty percent) 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**	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 scrutinize the Employer's Requirements with reference to purpose, scope, design and /or other technical criteria, installation, testing and commissioning, particular specifications for the works. 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, installation, testing and commissioning, particular specifications 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**	**New Sub-Clause** 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 by the following:** Whole of the Works shall be completed within 24 months from the Commencement Date. **Milestone – 1: 12 months from the Commencement Date.** a) Completed the erection of 30% of all OHE masts and portals (put together) required in the contract; and b) Completed the erection of 25% of all cantilevers (bracket insulators, bracket tube, stay tube, register arm and steady arm) for OHE masts and portals (put together) required in the Contract; and c) Supply of S&T equipment and its progressive installation entitling him a payment of at least 10% of the Accepted Contract Amount for S&T Works. **Milestone – 2: 18 months from the Commencement Date** a) Completed the erection of 70% of all OHE masts and portals (put together) required in the Contract; and b) Completed the erection of 50% of all cantilevers (bracket insulators, bracket tube, stay tube, register arm and steady arm) for OHE masts and portals (put together) required in the Contract; and c) Supply of Contract Wire, Catenary Wire and Feeder Wire 60% of km required (put Together) d) Wiring of Contract Wire, Catenary Wire and feeder Wire 20% of total TKM. e) PSI work - completion of 70% of equipment foundations (put together); 20% of equipment erection (put together) and supply of power, Traction and Auto transformers. f) 70% of laying of Outdoor Signaling & Telecom Cable and their Termination & Cable Testing. g) Supply of S&T equipment and its progressive installation entitling him a payment of at least 50% of the Accepted Contract Amount for S&T Work. **Milestone – 3: 24 months from the Commencement Date.** Completing all works as per the contract to enable certification including Integrated Testing & Commissioning and certification by an authority nominated by employer and taking over the entire works.
Sub-Clause 8.3	**Delete para 3 of Sub- Clause 8.3** "The Contractor shall …… *[Variation Procedure]."*
Sub-Clause 8.4	**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 by the following:** The Contractor shall complete the Works in accordance with the programme 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, it 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 Contract shall apply as if Appendix to Tender has been amended as above; provided further that in the event Project is completed within the Time for Completion as stated in the Appendix to Tender, 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. The Employer shall notify the Contractor of its decision to impose Delay Damages in pursuance with the provisions of this Sub-Clause. Provided that no deduction on account of Delay Damages shall be effected by the Employer without notifying the Contractor its decision to impose the Damages. 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,** **Substitute deletion by 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 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

<table>
<tr><td></td><td>same shall be stated.</td></tr>
<tr><td>Sub-Clause 13.7
Adjustments for Changes in Legislation</td><td>Delete first paragraph of the Sub-Clause and Substitute deletion by 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 that have a direct effect on the Project which affect the Contractor in the performance of obligations under the Contract.

End of the Sub-Clause
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.</td></tr>
<tr><td>Sub-Clause 13.8 Adjustment for Changes in Cost</td><td>Delete Paragraph 3 of this Sub-Clause and Substitute deletion by the following:
The adjustment to be applied to the amount otherwise payable to the Contractor, as valued in accordance with the amount certified in Payment Certificates for cost centers (sub clause 14.4), shall be determined from formulae.
The formula for adjustment for changes in cost shall be as follows except for cost center for
<table><tr><th>SN</th><th>Item</th><th>Cost center</th></tr><tr><td>I)</td><td>Contact/ catenary wire</td><td>C2.1 & C2.2</td></tr><tr><td>II)</td><td>Traction transformers /Auto transformers/ Power transformer</td><td>C3.1 C3.2, C3.3, C4.1 & C5.1</td></tr></table>
for which PVC formula has been given separately.
For other cost centers the PVC formula will be as follows:
Pn = a + b(Ln/L0) + c(Mn/M0) + d(Un/U0)
where:
"Pn" is the adjustment multiplier to be applied to the contract amount paid against cost center / stage as per Price Schedule for the completed stage of work;</td></tr>
</table>

	"a" is a fixed coefficient, stated in the table of adjustment data as given below, representing the non-adjustable portion of the work; "b" is a fixed coefficient, stated in the table of adjustment data as given below, representing the adjustable portion for labour component; "c" is a fixed coefficient, stated in the table of adjustment data as given below, representing the adjustable portion for material component; "d" is a fixed coefficient, stated in the table of adjustment data given below, representing the adjustable portion for fuel component; Values of a, b, c and d are as under for Cost center **C-2, C-3, C-4, C-5 & C-6** (other than (i) & (ii) above) of electrical price schedules: Fix Component (a) 0.15 Labour (b) 0.30 Material (c) 0.40 Fuel (d) 0.15 Values of a, b, c and d are as under for Cost center **C-1, C-7, C-8, C-9 & C-10** of electrical and **D-1, D-2, D-3. D-4, D-5, D-6, D-7, D-8 & D-9** of Signaling, **E-1, E-2, E-3, E-4, E-5, E-6, E-7, E-8 & E-9** of Telecommunication and **F-1** of Building & Structure works price schedules : Fix Component (a) 0.30 Labour (b) 0.30 Material (c) 0.25 Fuel (d) 0.15 Values for "Ln", "Mn" and "Un" correspond to the date 49 days prior to the last day of the period (to which the particular payment certificate relates) and shall be as follows : "Ln" The All India Consumer Price Index for Industrial Works as published by the Labour Bureau, Ministry of Labour, Govt. of India. "Mn" The Wholesale Price Index for All Commodities as published by Economic Advisor, Ministry of Commerce, Govt. of India. "Un" The Wholesale Price Index for Fuel (High Speed Diesel – code: 1200020005) as published by Economic Advisor, Ministry of Commerce, Govt. of India. Values for "Lo", "Mo" and "Uo" correspond to the base date and shall be as follows : "Lo" The All India Consumer Price Index for Industrial Works as published by the Labour Bureau, Ministry of Labour, Govt. of India on the base date. "Mo" The Wholesale Price Index for All Commodities as published by Economic Advisor, Ministry of Commerce, Govt. of India on the base date. "Uo" The Wholesale Price Index for Fuel (High Speed Diesel – code:

1200020005) as published by Economic Advisor, Ministry of Commerce, Govt. of India on the base date.

a) Price Variation Clause for Contact and Catenary Wires (Cost centre : C2.1 & C 2.2)

The formula for adjustment for changes in cost shall be as follows

$$Pn = 0.15 + 0.85\frac{CU_n}{CU_o}$$

where:

"Pn" is the adjustment multiplier to be applied to the contract amount paid against cost center/ stage as per Price Schedule for the completed stage of work;

CU_n = Average LME cash settlement quotation for Copper Grade A 90 days prior to the "***date of delivery"***

CU_o = Average LME cash settlement quotation for Copper Grade A 60 days prior to date of opening of tender.

Notes:

- For prevailing LME rates, certified copy of LME rate downloaded from official LME website will be accepted as documentary evidence.
- LME rate in CU_o & CU_n will be converted to Indian Rupees at SBI's Selling Bills rate of exchange on the date 30 days prior to the date of opening of tender and date of delivery respectively.

b) Price Variation Clause for Power Transformers complete with all accessories and components (of ratings above 10 MVA or Voltage above 33kV) issued vide ieema circular No. IEEMA/PVC/PWR TRF upto 400 KV/2015 effective from 1st April, 2015 & circular No. 85/DIV/TRF/05 dated June 05, 2015 shall be applicable " : (Cost centre: C3.1, C3.2, C3.3, C4.1 and C5.1)

P =	Price payable as adjusted in accordance with the above formula.
P_o =	Price quoted/confirmed.
C_0 =	Average LME settlement price of copper wire bars This price is as applicable for the month, one months prior to the date of tendering.
ES_0 =	Price of CRGO Electrical Steel lamination This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.
IS_0=	Average Price of steel plates 10mm thick This price is as applicable on the first working day of the month, one month prior to the date of tendering.
IM_0 =	Price of Insulating Materials

	This price is as applicable on the 1st working day of the month, one month prior to the date of tendering TO_0 = Price of Transformer Oil This price is as applicable on the 1st working day of the month, one month prior to the date of tendering. W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt of India(Base 2001=100) This index number is as applicable on the first working day of the month, three months prior to the date of tendering. (For example, if date of tendering falls in June 2015, the applicable prices of Copper Wire Bars (C_o), Transformer Oil (TO_o), Steel Plates 10 mm thick (IS_o), CRGO Electrical Steel laminations (ES_o),and insulating material (IM_o) should be as on 1st May 2015 and all India average consumer price index no. (W_o) should be for the month of 1st March 2015. The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/PWR_TRF/_/_ **ONE** month prior to the date of tendering) C = Average LME settlement price of copper wire bars This price is as applicable for the month, **TWO** months prior to the date of delivery. ES = Price of CRGO Electrical Steel Lamination This price is as applicable on the 1st working day for the month, **TWO** months prior to the date of delivery. IS = Average price of Steel Plates 10 mm thick This Price is as applicable on the 1st working day of the month, **ONE** months prior to the date of delivery. IM = Price of Insulating Materials This price is as applicable on the 1st working day of the month, **TWO** months prior to the date of delivery. TO = Price of Transformer Oil This price is as applicable on the 1st working day for the month, **ONE** month prior to the date of delivery. W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt of India (Base 2001-100) This index number is as applicable on the first working day of the month, **THREE** months prior to the date of delivery. (For examples, if date of delivery in terms of clause given below falls in December 2015, the applicable prices of Copper Wire Bars ©, Insulating

	material (IM), CRGO Electrical Steel Lamination (ES) should be as on 1st October 2015 and Transformer Oil (TO), Plates 10 mm thick (IS) should be 1st November 2015 and all India average Consumer Price Index no. (W) should be for the month of September 2015) *(The "**date of delivery**" is the date on which the transformer is notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier).* **Notes:** (a) All the prices of raw materials are exclusive of any central, state taxes & duties. transformers manufacturers import major raw materials like Copper, CRGO Steel Sheets and Plates etc. the landed cost of these imported raw materials includes applicable custom duty but exclusive of central and state taxes & duties. (b) All prices are as on first working day of the month. (c) The details of prices are as under: 1) The LME price of copper wire bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars converted into Indian Rupees with applicable exchange rate of SBI of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty. 2) The price of CRGO is the price of CRGO Electrical Steel Lamination in Rs./MT suitable for Transformers of rating above 10 MVA or voltage above 33 kV. 3) Price of steel is the average retail price of steel plates 10 mm thick as published by Joint Plant Committee (JPC) in Rs./MT as on 1st working day of the month. 4) The price of insulating materials (in Rs/Kg) of pre-compressed pressboards of size 10 mm thick, 3200 mmx4100mm is the average C&F price in free currency per MT converted into Indian rupees with applicable exchange rates prevailing as on 1st working day of the month as quoted by primary suppliers. The price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty. 5) The price of Transformer Oil (in Rs/K Ltr) is the average price on ex-refinery basis as quoted by primary producers for supply in drums.
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 14.2 **Advance Payment**	**Delete Paragraph 1 and substitute by the following :** The Employer shall make an advance payment, as an interest bearing loan for mobilisation and design, when the contractor submits a guarantee in accordance with this Sub-clause. The total advance payment, the number and timing of installments (if more than one), the rate of interest, and the applicable currencies and proportions shall be as stated in the Appendix to Tender.
	Delete Paragraph 14.2(a) and substitute by the following: Deductions shall commence in the Payment Certificate in which the total of all certified interim payments (excluding the advance payment and deductions and repayments of retention) exceeds twenty five per cent (25%) of the Accepted Contract amount less provisional sums; and
Sub-Clause 14.3 **Application for Interim Payment Certificates**	**Delete first paragraph of this Sub-Clause and substitute by the following:** The Contractor shall prepare his monthly bill, in the format agreed with the Engineer, in six copies (hard) and a soft copy. This shall be accompanied by supplementary details in two hard copies and a soft copy. All hard copies shall bear the original signatures of the Contractor and submitted to the Engineer. If these are found in order then Engineer shall forward the same with copy of supplementary details to the Employer, with Interim Payment Certificate, as per clause 14.6, for payment by the Employer, otherwise return back all documents to the Contractor for rectification and resubmission. Responsibility of preferring the bill 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 bills all supplementary details like measurements, sketches, drawings, approvals, calculations etc. shall accompany the bill so that payment can be substantiated by the Engineer as well as the Employer. Even if no stage of work is completed during the month or Contractor does not choose to prefer a bill a 'NIL' bill shall be submitted by him. **Paragraph 2 (a) third line Delete the word "(g)" and substitute by "(h)"** **Add the following paragraph at the end** (h) any amount to be deducted for taxes 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 given in Part 5, Schedule C (C1 to C10) for Electrical works , Schedule D (D1 to D9) for signalling Works , Schedule E (E1 to E9) for Telecommunication Works & Schedule F for Civil Structure and Building Works 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 Work has been divided into four (4) main Cost centres (C to F) along with their respective weightage percentages of the Contract Price in Annexure-I of Schedule A. Each of the cost centres has been broken into items of works with percentage weightage of the Contract Price to items of the works/stages as indicated in Schedules C1 to C10, D1 to D9, E1 to E9 & F1. (c) The Bidder shall compute, and supply to the Engineer, the total quantities (in units as described in the Price Schedules) 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 centres 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.
Sub-Clause 14.6 **Issue of Interim Payment Certificates**	In the 1st Paragraph, 2nd line, '28' is replaced with '15'.
Sub Clause 14.7 **Payment**	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 the contents of first paragraph of this clause and replace with the followings:** 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. The contractor may replace the Retention Money deducted from Interim Payment Certificate on the quarterly basis with an unconditional bank guarantee from the Bank of Equivalent amount for the respective currency portions. The Bank Guarantees shall be valid up to the end of Defect notification period.
Sub-Clause 15.2 **Termination by Employer**	**Delete the words "the whole of" in Sub-Clause (d) and Substitute the deletion by the following words"** more than the percentage specified in 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 by the following:** Work completed upto 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/Security Deposit (3) five percent (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 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 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 (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/Security Deposit and five percent(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	**Delete the sub-clause 16.2 (d)** **Delete the following words from 16.2 (e)**

Contractor	" of Sub-clause 1.7 [Assignment]"
Sub-Clause 17.3 **Employer's Risks**	**Sub-paragraph (h) - Delete**
Sub-clause 18.1 General Requirement of Insurance	**Sub –paragraph 7 (b) Modify as following** **"copies of the policies for the insurances described in Sub-clause 18.2 (Insurance for works and Contractor's Equipment), Sub Clause 18.3 (Insurance against Injury to Person and Damage to Property) and 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 by 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 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 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 new sub-clause** The Contractor shall provide evidence of professional indemnity insurance carried by its Designer for the Works. The professional indemnity insurance shall cover the risk of professional negligence in the design of the Works. This insurance shall be for a limit of not less than that set down in the Appendix to Tender and shall be maintained in full force and effect from the Commencement Date of the Works until 03 years after the date of completion of the Defect Notification period. The Engineer will not issue any payment certificate until the Contractor has provided evidence of this insurance and its period of effectiveness.
Sub Clause 20.6 **Arbitration**	**Delete Sub-paragraph 1 (a, b & c) and replace as under –** Unless settled amicably, any dispute in respect of which the DAB's decision (if any) has not become final and binding shall be finally decided by reference to arbitration by a Board of Arbitrators appointed in accordance with sub-clause (i) below. Such arbitration shall be held in accordance with **The Arbitration and Conciliation (Amendment) Act, 2015**. The seat of such arbitration shall be New Delhi, and the language of arbitration proceedings shall be English. i) The employer shall provide a panel of five (5) arbitrators to the contractor. The employer at the time of offering the panel of

	Arbitrator(s) to be appointed as Arbitrator shall also supply the information with regard to the qualification of the said Arbitrators nominated in the panel along with their professional experience, phone no. and address to the contractor. The contractor shall have to choose one Arbitrator from the panel of five. The employer shall also choose one Arbitrator from this panel of five. The third arbitrator shall be appointed by the two arbitrators from the panel of five so selected and shall act as presiding arbitrator. In case of failure of the two Arbitrators, appointed by the parties, to reach upon a consensus within a period of 28 days from their appointment as Arbitrators, the Presiding Arbitrator shall then be appointed by MD/DFCCIL. Arbitrator's Fee and other admissible expenses shall be as per extant DFCCIL instructions.

APPENDIX TO TENDER

<table>
<tr><th>Item</th><th>GC Sub-Clause</th><th>Data</th></tr>
<tr><td>Employer</td><td>1.1.2.2, 1.3</td><td>Dedicated Freight Corridor Corporation of India Limited,
5th Floor Pragati Maidan, Metro Station Building Complex
New Delhi, India – 110001</td></tr>
<tr><td>Contractor</td><td>1.1.2.3 & 1.3</td><td>To be filled in</td></tr>
<tr><td>Engineer</td><td>1.1.2.4, 1.3 & 3.1</td><td>to be filled in</td></tr>
<tr><td>Time for Completion</td><td>1.1.3.3</td><td>As per Sub-clause 8.2 of GC</td></tr>
<tr><td>Defects Notification Period</td><td>1.1.3.7</td><td>Defect Notification Period for the Works shall be two year from the date of Taking Over of the Works (Sub-clause 10.1) and issue of Taking-Over Certificate by the Engineer.</td></tr>
<tr><td>Communications</td><td>1.3</td><td>By fax and e-mails but confirmed in hard paper copy within 48 hours.</td></tr>
<tr><td>Law and Language</td><td>1.4</td><td>Indian Laws & English Language</td></tr>
<tr><td>Right of Access to the Site</td><td>2.1</td><td>The Employer shall give Right to Access to site to the system Contractor as per the following schedule subject to the Contractor providing Performance Security in terms of Sub-Clause 4.2 of General Conditions of Contract.
<table>
<tr><th>SN</th><th>Period after Commencement Date in month</th><th>Cumulative percentage of formation to be handed over for work with respect to total length</th></tr>
<tr><td>1</td><td>01</td><td>20%</td></tr>
<tr><td>2</td><td>03</td><td>30%</td></tr>
<tr><td>3</td><td>09</td><td>60%</td></tr>
<tr><td>4</td><td>18</td><td>100%</td></tr>
</table>
The Employer shall give access to track for construction and/or for running of material trains, tower wagons, rail cum road vehicle etc in stages as under:
<table>
<tr><th>SN</th><th>Period after Commencement Date in months</th><th>Cumulative percentage of track to be handed over for work with respect to total length</th></tr>
<tr><td>1</td><td>10</td><td>10%</td></tr>
<tr><td>2</td><td>14</td><td>30%</td></tr>
<tr><td>3</td><td>20</td><td>100%</td></tr>
</table>
The above schedule is indicative.
The Employer shall give the contractor Right of access to and</td></tr>
</table>

Item	GC Sub-Clause	Data
		possession of the site progressively to enable the contractor to complete the work as per schedule. The Right and possession may not be exclusive to the contractor. The contractor shall draw/modify the schedule for completion of works according to progressive possession/Right of access of such sites. Percentage of track to be handed over for the work may not be at a continuous stretch. The contractor should plan his work accordingly. If there is any delay in handing over of site/s, contractor shall be entitled to only reasonable extension of time and no other claims what so ever shall be paid or entertained on this account.
Amount of Performance Security	4.2	(Five) 05 Percent of the Accepted Contract Amount, in INR currency.
General Design Obligation	5.1	56 days.
Normal working hours	6.5	(Eight) 8 hours shift in a day and total (Forty eight) 48 hours in a week.
Amount of Delay Damages	8.7	**For Milestone 1** - (Rupees one hundred thousand) Rs. 100,000/- per day of delay. **For Milestone 2** - ` (Rupees one hundred thousand) Rs. 100,000/- per day of delay. **For Milestone 3** - ` (Rupees one hundred thousand) Rs. 100,000/- per day of delay.
Limit of Delay Damages for the whole of the Works	8.7	(Five) 05 per cent of the Accepted Contract Amount in INR ` Indian currency.
Provisional Sum	13.5	No Provisional Sum is payable under this Contract.
Advance Payment	14.2	**Delete Paragraph 1 and substitute by the following :** **Mobilization Advance:** The Employer shall pay on written request by the Contractor a Mobilization Advance up to (Ten) **10** per cent of the Contract Price at an interest rate of 4.5% per annum above the MCLR of State Bank of India for two years tenor as effective on the date of approval of payment of mobilization advance by the competent authority, compounded yearly. The Mobilization Advance shall be released in two installments as under: (a) **Upto (Five) 5 percent:** On Submission of Performance Security and commencement of mobilization process; and (b) **Upto (Five) 5 percent:** On Submission of the preliminary designs 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 110% of the component of the advance payment requested by

<table>
<tr><th>Item</th><th>GC Sub-Clause</th><th>Data</th></tr>
<tr><td></td><td></td><td>the Contractor.

Note: The Contractor shall have a onetime option to reduce the Bank Guarantee for the mobilization advance by the amount already recovered, once the 50% of mobilization advance has been recovered.</td></tr>
<tr><td>Percentage of Retention</td><td>14.3 (c)</td><td>(Ten) 10 per cent</td></tr>
<tr><td>Limit of Retention Money</td><td>14.3 (c)</td><td>(Five) 5 per cent of the Contract Price</td></tr>
<tr><td>Payment</td><td>14.7</td><td>As per Sub-clause 13.4 of GC above</td></tr>
<tr><td>Delayed Payment</td><td>14.8</td><td>These financing charges shall be calculated at an annual rate of 8% (Eight percent) of Indian Currency.</td></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 signing of the Contract Agreement
</td></tr>
<tr><td>Evidence of Insurance</td><td>18.1 (a), 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>Insurance of Works and Contractors Equipment</td><td>18.2</td><td>Full Replacement Cost+15%; The Insurance Policy to cover the Employer’s Risk as per Sub-Clause 17.3 of GC shall be taken by the Employer.</td></tr>
<tr><td>Minimum amount of third party Insurance</td><td>18.3</td><td>Rs.50 lakh for any one occurrence.</td></tr>
<tr><td>Professional Indemnity Insurance</td><td>18.5</td><td>Rs. 200 lakh</td></tr>
<tr><td>Appointment of Dispute Adjudication Board</td><td>20.2</td><td>The DAB shall comprise of one Sole member and sole member shall be appointed by Managing Director/DFCCIL.</td></tr>
<tr><td>Failure to Agree Dispute Adjudication Board</td><td>20.3 (d)</td><td>Managing Director/DFCCIL</td></tr>
</table>

[1] To be filled at the time of signing the contract.

Section VIII

CONTRACT FORMS

Section VIII
Contract Forms (CF)

Table of Forms

CF No	Sub-Clause	Description
01	1.1.1.3	Letter of Acceptance
02	1.6	Form of Contract Agreement
03	4.2	Form of Performance Security (Guarantee) By Bank
04	14.2	Mobilization Advance Payment Guarantee Form
05	14.3 c, 14.9	Form of Retention Money Guarantee
06	4.4	Memorandum of Understanding for a Subcontracting Agreement
07	4.4	Sub-Contractor's Warranty
08	5.1, 18.5	Form of Designer's Warranty
09	18	Insurance Requirement
10	14.3, 14.7	Standing Indemnity Bond For 'On Account' Payments

CF-1

LETTER OF ACCEPTANCE

(Sub-Clause 1.1.1.3)

To

Date:…….

Dear Sir

Project: DESIGN, SUPPLY, CONSTRUCTION, INSTALATION,OF 2X25 KV ELECTRIFICATION, SIGNALLING AND TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA- NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.

To,

This is to notify you that your bid proposal dated……..for execution of the above Project for the firm Contract Price of …… (INR) and as corrected and modified in accordance with the bidding documents, is hereby accepted by DFCC.

You are requested to furnish the performance security as required by the contract and bidding document.

You are hereby instructed to proceed and prepare your mobilization for the execution of the said Contract works. Contract Agreement documents will be prepared and forwarded to you for signature.

Yours truly,

For – Dedicated Freight Corridor Corporation of India Limited

(_____)
Name:…….

Signature

Stamp

CONTRACT AGREEMENT

(Sub-Clause 1.6 of General Conditions of Contract)

THIS AGREEMENT ("Agreement") is made at New Delhi on 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'**),and **----------,** a company/corporation/JV incorporated under the laws of ----------having its principal place of business at ---------- (hereinafter called "**the Contractor**").

WHEREAS the Employer desires to engage the Contractor to**: DESIGN, SUPPLY, CONSTRUCTION, INSTALATION, OF 2X25 KV ELECTRIFICATION, SIGNALLING AND TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA - NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR. (System Works),** and the Contractor has agreed to such engagement upon and subject to the terms and conditions hereinafter appearing.

NOW IT IS HEREBY AGREED as follows:

Article 1.
Contract Documents

1 Contract Documents (Reference GC Clause 1.5)

The following documents shall constitute the Contract between the Employer and the Contractor, and each shall be read and construed as an integral part of the Contract:

This Contract Agreement and the Appendices hereto

Letter of Acceptance

Letter of Bid and Price Schedules submitted by the Contractor

Particular Conditions & Appendix to Tender

General Conditions

Employer's Requirements

Contractors Technical & Financial Proposal;

Information furnished in Part 4 of Bidding document

Other completed bidding forms submitted with the Bid; and

Any other documents forming part of the Employer's requirements and Bidding documents.

Definitions (Reference GC Clause 1 and Employer's Requirement)

Capitalized words and phrases used herein shall have the same meanings as are ascribed to them in the General Conditions & Employer's Requirements.

Article 2.
Contract Price and Terms of Payment

Contract Price (Reference GC Clause 14.1)

The Employer hereby agrees to pay to the Contractor the Contract Price in consideration of the performance by the Contractor of its obligations pursuant to the Contract. The Contract Price shall be as specified in Schedule A Price Schedule and the payment in local and foreign currencies shall be done in

	accordance to the Annexure-I & Annexure-II of Schedule A, or such other sums as may be determined in accordance with the terms and conditions of the Contract. Terms of Payment (Reference GC Clause 14.4) The terms and procedures of payment according to which the Employer will reimburse the Contractor are given in Terms and Procedures of Payment subject to such additions thereto or deductions there from as may be made under the provisions of the contract at the times and in the manner prescribed by the Contract. The amount payable under Schedule – C1 to C10, D1 to D9, E1 to E9 and F1 is adjusted in accordance with GC 13.8 or with any of the other terms of the Contract.
Article 3. **Commencement Date**	Commencement Date (Reference GC Clause 1.1.3.2) 42 days from the date of issue of letter of acceptance or as indicated in the letter of acceptance.
Article 4. **Time for Completion**	4.1 Completion (Reference Clause 1.1.3 GC & ---- Employer's Requirements) In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the contractor hereby covenants with the Employer to execute and complete the Works by 24 months and remedy any defects therein in conformity in all respect with the provisions of the Contract.
Article 5. **Communications**	The address of the Employer for notice purposes, pursuant to GC 1.3 is: The Chief Project Manager, Dedicated Freight Corridor Corporation, Swarna Complex, 2nd Floor, Susuwahi, Post – Susuwahi, Thana – Lanka, Varanasi, India – 221011 5.2 The address of the Contractor for notice purposes, pursuant to GC 1.3 is: _____.
Article 6. **Obligations of the Contractor**	6.1 Contractor's General Obligation GC 4.1 The Contractor shall ensure full compliance with the laws of India including taxation and other fiscal laws, with regard to the Contract and the Works shall be solely responsible for the same. The Contractor shall submit copies of acknowledgements evidencing filing of returns every year and shall keep the Employer fully indemnified against liability of levies, custom duties, tax, interest, penalty etc. of the Contractor in respect thereof, which may arise.

IN WITNESS WHEREOF the parties hereto have caused their respective Common Seals to be hereunto affixed/ (or have hereunto set their respective hands and seals) the day and year first above written.

For and on behalf of the Contractor	For and on behalf of the Employer
Signature of the authorized official Name of the official	Signature of the authorized official Name of the official
Stamp/seal of the Contractor	Stamp/Seal of the Employer

SIGNED, SEALED AND DELIVERED

By the said
_____Name
_____
on behalf of the Contractor in the presence of:

Witness _____

Name _____

Address _____

By the said
_____Name
_____
on behalf of the Employer in the presence of:

Witness _____

Name _____

Address _____

CF-3

FORM OF PERFORMANCE SECURITY (GURANTEE) BY BANK

(Sub-Clause 4.2)

This deed of guarantee made this day of ……. Between Bank of (hereinafter called the "**Bank**") of the one part, and Dedicated Freight Corridor Corporation of India Limited called the "**Employer**" of the other part.

Whereas Dedicated Freight Corridor Corporation of India Limited has awarded the contract for …… (Hereinafter called the Contract) to ……. (Hereinafter called the **Contractor**). (Name of the Contractor)

AND WHEREAS the Contractor is bound by the said Contract to submit to the Employer a Performance Security for a total amount of Rs…… (Amount in figures and words). Now we the undersigned ……..(Name of the Bank) being fully authorized to sign and to incur obligations for and on behalf of and in the name of ……..(full name of the Bank), hereby declare that the said bank will guarantee the Employer the full amount of Rs. ……(Amount in figures and words).

After the Contractor has signed the aforementioned Contract with the Employer, the Bank is engaged to pay the Employer, any amount up to and inclusive of the aforementioned full amount of the Performance Security upon written order from the Employer to indemnify the Employer for any liability of damage resulting from any defects or shortcomings of the Contractor or the debts he may have incurred to any parties involved in the Works under the Contract mentioned above, whether these defects or shortcomings or debts are actual or estimated or expected. The Bank will deliver the money required by the Employer immediately on demand without delay and demur and without reference to the Contractor and without the necessity of a previous notice or of judicial; or administrative procedures and without it being necessary to prove to the Bank the liability or damages resulting from any defects or shortcomings or debts of the Contractor. The Bank shall pay to the Employer any money so demanded notwithstanding any dispute/disputes raised by the contractor in any suit or proceedings pending before any court, Tribunal or Arbitrator/s relating thereto and the liability under this guarantee shall be absolute and unequivocal.

This guarantee is valid till ……..(the initial period for which this Guarantee will be valid must be for at **least 6 months (six months) longer than the anticipated expiry date of Defects Notification Period as stated in Clause 1.1.3.7 of the Appendix to Tender.**

At any time during the period in which this guarantee is still valid, if the Employer agrees to grant a time extension to the Contractor or if the Contractor fails to complete the Works within the time of completion as stated in the Contract, or fails to discharge himself of the liability or damages or debts as stated in the Contract, or fails to discharge himself of the liability or damages or debts as stated in the Contract, it is understood that the Bank will extend this guarantee under the same conditions for the required time on demand by the Employer and at the cost of the Contractor.

The Guarantee hereinbefore contained shall not be affected by any change in the Constitution of the Bank or of the Contractor.

The neglect or forbearance of the Employer in enforcement of payment of any moneys, the payment whereof is intended to be hereby secured or the giving of time by the Employer for the payment hereof shall in no way relieve the Bank of their liability under this deed.

The expressions "**the Employer**", "**the Bank**" and "**the Contractor**" hereinbefore used shall include their respective successors and assigns.

Notwithstanding anything contained herein:

Our liability under this bank Guarantee shall not exceed Rs…….(Rupees ……).

This bank guarantee shall be valid up to …….

We are liable to pay the guarantee amount or part thereof under this bank Guarantee only and only if you serve upon us a written claim or demand on or before……

In witness whereof I/We of the Bank have signed and sealed this guarantee on the …… day of …….. (Month) being herewith duly authorized.

For and on behalf of

The …….bank

Signature of Authorized bank Official

Name ……..

Designation ……..

Stamp/seal of the Bank:……..

Signed, sealed and delivered

For and on behalf of the

Bank of the above

Name_____in

The presence of :

Witness 1.	Witness 2.
Signature ……	Signature ……..
Name ……	Name ……
Address ……	Address …….

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Mobilization Advance Payment Guarantee Form

(Sub-Clause 14.2)

Bank guarantee made on this …… Between ……. (here in after called "**the Bank**") of the One Part and Dedicated Freight Corridor Corporation of India Limited. (here in after called "**the Employer**") of the other Part.

WHEREAS Dedicated Freight Corridor Corporation of India Limited has awarded the Contract no……. for "……" (here in after called "**the Contract**") to ……. Having its registered office at …… (here in after called "**the Contractor**").

AND WHEREAS vide Clause 14.2 of the General Conditions of Contract, Mobilization Advance up to ---% (--- percent) of the original contract value of Rs…….. is payable to the contractor against Bank Guarantees, the Contractor hereby applies for Mobilization Advance of --% (--- percent) amounting to Rs……../- (Rupees……..) of the Contract Price, as per Appendix to Tender

AND WHEREAS this Bank Guarantee is for Rs……/-(Rupees……..) being the 1st one of the two Bank Guarantees, totaling to the above Mobilization Advance amount of Rs……/-.

Now, we the undersigned, Bank of ……., being fully authorized to sign and to incur obligations for and on behalf of and in the name of Bank of ……..hereby declare that the said Bank will guarantee the Employer the full amount of Rs. ……../- (Rupees……..) as stated above.

We, Bank of ……., do hereby unconditionally, irrevocably and without demur guarantee and undertake to pay the Employer immediately on demand any or all money payable by the Contractor to the extent of Rs. ……./-(Rupees……..) without any demur, reservation, context, recourse or protest and/or without any reference to the Contractor. Any such demand made by the Employer on the Bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor on any dispute pending before any court, Tribunal, Arbitrator or any other authority. We agree that the guarantee herein contained shall be irrevocable and shall continue to be enforceable till the Employer discharges this guarantee.

This guarantee is valid till ……..

At any time during the period in which this guarantee still valid of the Contractor fails to fulfill its obligation under the Contract, it is understood that the Bank will extend this guarantee under the same condition for the required time on demand by the Employer at the cost of the Contractor.

The Guarantee hereinbefore contained shall not be affected by any change in the constitution of the Bank or of the Contractor.

The neglect or forbearance of the Employer in enforcement of payment of any money, the payment whereof is intended to be hereby secured or the giving of time by the Employer for the payment hereof shall in no way relieve the Bank of their liability under this Deed.

The expressions "the Employer", "the Bank" and "the Contractor" hereinbefore used shall include their respective successors and assigns.

Notwithstanding anything contained herein:

Our liability under this Bank Guarantee shall not exceed Rs……./- (Rupees…….)

this bank Guarantee shall be valid up to……..

We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before ……(date of expiry of Guarantee).

In witness whereof we of the Bank have signed and sealed this Guarantee on the ……day of ……..being herewith duly authorized.

For and on behalf of the Bank of…….

Signature of Authorized Bank Official

Name _____

Designation _____

Stamp/Seal of the bank _____

Signed, sealed and delivered for and on

Behalf of the bank by the above named

…….. in the presence of

Witness 1

Signature _____

Name _____

Address _____

Witness 2

Signature _____

Name _____

Address _____

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FORM OF RETENTION MONEY GUARANTEE

(Sub-Clause 14.3 c, 14.9)

Brief description of Contract

Name and address of Beneficiary

_____ (whom the Contract defines as the Employer).

We have been informed that _____ (hereinafter called the "Principal") is your Contractor under such Contract and wishes to receive early payment of [part of] the retention money, for which the Contract requires him to obtain a guarantee.

At the request of the Principal, we (*name of bank)* _____ hereby irrevocably undertake to pay you, the Beneficiary / Employer, any sum or sums not exceeding in total the amount of _____ (the "Guaranteed Amount", say: _____) upon receipt by us of your demand in writing and your written statement stating:

a) that the Principal has failed to carry out his obligation(s) to rectify certain defect(s) for which he is responsible under the Contract, and

b) the nature of such defect(s).

c) That the Principal has failed to carry out his obligation(s) for which he is responsible under the Contract,

At any time, our liability under this guarantee shall not exceed the total amount of retention money released to the Principal by you, as evidenced by your notices issued under Sub-Clause 2.5 and 14.9 of the Conditions of the Contract with a copy being passed to us.

Any demand for payment must contain your signature(s) which must be authenticated by your Bankers. The authenticated demand and statement must be received by us at this office on or before (*the date 56 days after the expected expiry of the Defects Notification Period for the Works)* _____ (the "**Expiry Date**"), when this guarantee shall expire and shall be returned to us.

We have been informed that the Beneficiary may require the Principal to extend this guarantee if the performance certificate under the Contract has not been issued by the date 28 days prior to such Expiry Date. We undertake to pay you such Guaranteed Amount upon receipt by us, within such period 28 days, of your demand in writing and your written statement that the performance certificate has not been issued, for reasons attributable to the Principal, and that this guarantee has not been extended.

This guarantee shall be governed by the laws of Republic of India.

Date Signature(s)

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MEMORANDUM OF UNDERSTANDING FOR A SUBCONTRACTING AGREEMENT

(Sub-Clause 4.4)

Date :
Project :

To
The Managing Director
DFCCIL

Dear Sirs

In accordance with the Sub-clause 4.4 of General Conditions of Contract read along with the Particular Conditions of Contract, we enclose this Memorandum of Understanding to enter into a subcontracting agreement between the Contractor _____ and the Sub-contractor _____to undertake the following:

1. Whereas the Employer requires the work of the project to be executed by the Contractor, and has accepted a bid by the Contractor for the execution and completion of the Works, and remedying any defects therein, the Contractor and the Subcontractor shall provide a formal agreement to the Employer prior to signature of Contract between the Employer and the Contractor.

2. The scope of work to be undertaken by the Sub-contractor is described as:

3. The work undertaken by the Sub-contractor does not relieve the Contractor from any liability or obligation under the Contract, and the Contractor shall, at all times, be solely responsible for the acts, defaults, and neglects of the Sub-contractor, his agents, servants and workmen as if anywhere the acts, defaults, neglects, of the Contractor, his agents, servants or workmen.

4. The Contractor shall provide insurance for the Subcontractor to the same level as his own insurance to include the Works executed under the subcontract agreement to be executed, and for the subcontractor's equipment as listed in Attachment to this MOU.

5. The Employer shall consider and approve the provisions of a signed subcontracting agreement prior to signature of Contract with the Contractor, as a reason for disqualifying the Contractor. The Employer shall also consider the non-fulfillment of any of the subcontract agreement terms as a reason for termination of the Contract, and upon 14 day's notice require the Contractor to vacate the Site. After such termination of the Contract by the Employer, the Employer may complete the work and or arrange any other authorities to do so.

Signed on this _____ day of _____ month _____ year.

The Contractor
(Signature & Seal)

The Subcontractor
(Signature & Seal)

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SUB-CONTRACTOR'S WARRANTY

(Sub-Clause 4.4)

THIS AGREEMENT is made the day of

BETWEEN:

1. [ ] [whose registered office is at]/[of] [ ] ("the Sub-contractor") and

2. The Dedicated Freight Corridor Corporation of India Limited (together with its successors and assigns, "the Employer") of:

   5th Floor, Pragati Maidan Metro Station,
   New Delhi,
   India 110001.

WHEREAS

(A) By a contract ---------- dated [ ] ("**the Contract**") made between (1) Dedicated Freight Corridor Corporation India Limited ("the Employer")

and (2) [ ] ("the Contractor"), the Contractor has agreed to design, execute, complete, test and commission (including integrated testing and commissioning) and remedy any defects in works upon the terms and conditions contained in the Contract.

(B) The Sub-contractor has had an opportunity of reading and noting the provisions of the Contract (other than details of the Contractor's prices and rates).

(C) Pursuant to the Contract, the Contractor proposes to enter into an agreement with the Sub-contractor ("**the Sub-contract**") for the Sub-contractor to carry out and complete a part of the Works as more particularly described in the Sub-contract ("**the Sub-contract Works**").

(D) The Contract stipulates that the Contractor shall obtain the consent of the Engineer before entering into the Sub-contract, and that the Contractor shall procure that the Sub-contractor executes a warranty agreement ("**Warranty**") in favour of the Employer.

NOW IT IS HEREBY AGREED as follows:-

1 In consideration of the Engineer consenting to the Contractor and the Sub-contractor entering into the Sub-contract, the Sub-contractor warrants and undertakes to the Employer that:

(a) he will execute and complete the Sub-contract Works, and will carry out each and all of the obligations, duties and undertakings of the Sub-contractor under the Sub-contract when and if such obligations, duties and undertakings shall become due and performable, in accordance with the terms of the Sub-contract (as the same may from time to time be varied or amended with the consent of the Employer); and

(b) he will supply to the Contractor and in specific cases wherever required to the Engineer with all information as may be required from time to time in relation to progress of the Sub-contract Works.

2 The Sub-contractor undertakes to indemnify the Employer against each and every liability which the Employer may have to any person whatsoever and against any claims, demands, proceedings, loss, damages, costs and expenses sustained, incurred or payable by the Employer provided that the Sub-contractor shall have no greater liability to the Employer by virtue of this Warranty than the liability of the Contractor to the Employer under the Contract insofar as and to the extent that the same has arisen by reason of any breach by the Sub-contractor of his obligations under the Sub-contract.

3 No allowance of time by the Employer hereunder or by the Contractor under the Sub-contract nor any forbearance or forgiveness in or in respect of any matter or thing concerning this Warranty or the Sub-contract on the part of the Employer or the Contractor, nor anything that

the Employer or the Contractor may do or omit or neglect to do, shall in any way release the Sub-contractor from any liability under this Warranty.

4 The Sub-contractor agrees that he will not without first giving the Employer, not less than 21 day's prior notice in writing, exercise any right he may have to terminate the Sub-contract or treat the same as having been repudiated by the Contractor or withhold performance of its obligations under the Sub-contract.

5 (i) In the event that the Contract or the employment of the Contractor under the Contract is terminated for any reason whatsoever and if so requested by the Employer in writing within 21 days of such termination, the Sub-contractor shall carry out and complete his obligations under this Warranty and shall enter into a novation agreement with the Employer and the Contractor in which the Sub-contractor will undertake inter alia to perform the Sub-contract and be bound by its terms and conditions as if the Employer had originally been named as a contracting party in place of the Contractor. The said novation agreement will be in such form as the Employer may reasonably require.

(ii) In the event that the Employer does not require the Sub-contractor to enter into a novation agreement as required by Sub-clause 5(i), the Sub-contractor shall have no claim whatsoever against the Employer for any damage, loss or expense howsoever arising out of or in connection with this Warranty.

6 Insofar as the copyright or other intellectual property rights, in any plans, calculations, drawings, documents, materials, know-how and information relating to the Sub-contract Works shall be vested in the Sub-contractor, the Sub-contractor grants to the Employer, his successors and assignees a royalty free, non-exclusive and irrevocable license (carrying the right to grant sub-licenses) to use and reproduce any of the works designs or inventions incorporated and referred to in such documents or materials and any such know-how and information for all purposes relating to the Works of the Employer, without limitation the design, manufacture, installation, reconstruction, completion, reinstatement, extension, remedy of any defect of the Works. To the extent beneficial ownership of any such copyright or other intellectual property right is vested in anyone other than the Sub-contractor, the Sub-contractor shall use best endeavors to procure that the beneficial owner thereof shall grant a like license to the Employer. For the avoidance of doubt, any such license granted shall not be determined if the Sub-contractor shall for any reason cease to be employed in connection with the Sub-contract Works.

7 In the event of any ambiguity or conflict between the terms of the Sub-contract and this Warranty, the terms of this Warranty shall prevail.

8 The provisions of this Warranty shall be without prejudice to and shall not be deemed or construed so as to limit or exclude any rights or remedies which the Employer may have against the Sub-contractor whether in tort or otherwise.

9 Nothing contained in this Warranty shall vary or affect the Sub-contractor's rights and obligations under the Sub-contract.

10 The Employer shall be entitled to assign the benefit of this Warranty at any time without the consent of the Sub-contractor being required.

11 All documents arising out of or in connection with this Warranty shall be served:

(1) upon the Employer at [ ] , marked for the attention of [ ];

(2) upon the Sub-contractor, at [ ] India.

12 The Employer and the Sub-contractor may change their respective nominated addresses for service of documents to another address in India but only by prior written notice to each other. All demands and notices must be in writing.

13 This Warranty shall be governed by and construed according to the laws for the time being in force in India.

14 **(i) Any dispute or difference of any kind whatsoever between the Employer and the Sub-contractor arising under out of or in connection with this Warranty shall be referred to Arbitration in accordance with the Arbitration procedure as described in the Contract.**

(ii) In the event that the Employer is of the opinion that the issues in such a dispute or difference will or may touch upon or concern a dispute or difference arising under out of or in connection with the Contract ("the Contract Dispute") then provided that an arbitrator has not already been appointed pursuant to Clause 20, the Employer may by notice in writing to the Sub-contractor require and the Sub-contractor shall be deemed to have consented to the referral of such dispute or difference to the arbitrator to whom the Contract Dispute has been or will be referred.

(iii) Save as expressly otherwise provided, the Arbitrator shall have full power to open up, review and revise any decision, opinion, instruction, notice, order, direction, withholding of approval or consent, determination, certificate, statement of objection, assessment or valuation by the Employer's Representative or the Contractor relating to the dispute or difference.

(iv) This Warranty shall be governed by and construed according to the laws for the time being in force in India and the Sub-Contractor agrees to submit to the jurisdiction of the courts of Delhi/New Delhi.

IN WITNESS whereof this Warranty has been executed as a deed on the date first before written.

THE COMMON SEAL of

[ ]

was affixed hereto in)

the presence of:-)

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FORM OF DESIGNER'S WARRANTY

(Sub-Clause 5.1 and Sub-Clause 18.5)

THIS AGREEMENT is made the day of
BETWEEN:

(1) [ ] [whose registered office is at]/[of] [ ] ("the Designer"); and

(2) The Dedicated Freight Corridor Corporation of India Limited (together with its successors and assigns, "the Employer") of

5th Floor, Pragati Maidan Metro Station,
New Delhi,
India 110001.

WHEREAS:

(a) By a contract --------- dated [ ] ("the Contract") made between (1) Dedicated Freight Corridor Corporation India Limited ("the Employer") and (2) [ ] ("the Contractor"), the Contractor has agreed to design, execute, complete, test and commission (including Integrated Testing and Commissioning) and remedy any defect in the Works upon the terms and conditions contained in the Contract.

(b) The Designer has had an opportunity of reading and noting the provisions of the Contract (other than details of the Contractor's prices and rates).

(c) Pursuant to the Contract, the Contractor wishes to enter into an agreement with the Designer and Designer agrees to the wishes of the Contractor (the Consultancy agreement) to carry out the Contractor's obligations under the Contract in relation to the design and functions ascribed to the Designer in the Contract.

(d) The Contract stipulates that the Contractor shall ensure that the Designer executes a warranty agreement ("**Warranty**") in favour of the Employer.

NOW IT IS HEREBY AGREED as follows:

1 In consideration of the Employer not objecting to the Contractor and the Designer entering into the Consultancy Agreement, the Designer warrants and undertakes to the Employer that he has exercised and will continue to exercise all the skill and care to be expected of a professionally qualified and competent designer experienced in work of similar nature and scope as the Works in carrying out the design of the temporary and Permanent Works and in performing the other duties and functions ascribed to him in the Contract.

2 The Designer agrees that, in the event of the termination of the Contract by the Employer or its appointee, the Designer will, if so required by notice in writing given by the Employer, accept subject to Clause 4 given herein, the instructions of the Employer or his appointee to the exclusion of the Contractor in respect of the carrying out and completion of the Works upon the terms and conditions of the Consultancy Agreement.

3 The Designer further agrees that he will not, without first giving the Employer not less than 21 days' previous notice in writing, exercise any rights it may have to terminate the Consultancy Agreement or to treat the same as having been as repudiated by the Contractor or to discontinue the performance of any duties to be performed by the Designer pursuant thereto. The Designer's right to terminate the Consultancy Agreement or to treat the same as having been repudiated or to discontinue the performance thereof shall cease if, within such period of notice and subject to Clause 4, the Employer shall give notice in writing to the Designer requiring the Designer to accept the instructions of the Employer or his appointee to the exclusion of the Contractor in respect of the carrying out and completion of the Contract Works upon the terms and conditions of the Consultancy Agreement.

4 Any notice given by the Employer under Clause 2 or 3 above shall state that the Employer or his appointee accepts liability for payment of the fees payable to the Designer under the Consultancy Agreement and for performance of the Contractor's obligations under the

Consultancy Agreement, including payment of any fees outstanding at the date of such notice.

5 The Employer shall be entitled to assign the benefit of this Warranty at any time without the consent of the Designer being required.

6 All documents arising out of or in connection with this Warranty shall be served:

(1) upon the Employer at [ ] marked for the attention of [ ];

(2) upon the Designer at [ ].

7 The Employer and the Designer may change their respective nominated addresses for service of documents to another address in India but only by prior written notice to each other. All demands and notices must be in writing.

8 This Warranty shall be governed by and construed according to the laws for the time being in force in India.

9 (i) In the event that the Contract or the employment of the Contractor under the Contract is terminated for any reason whatsoever and if so requested by the Employer in writing within 21 days of such termination, the Designer shall carry out and complete his obligations under this Warranty and shall enter into a novation agreement with the Employer and the Contractor in which the Designer will undertake inter alia to perform the Design and be bound by its terms and conditions as if the Employer had originally been named as a contracting party in place of the Contractor. The said novation agreement will be in such form as the Employer may reasonably require.

(ii) In the event that the Employer does not require the Designer to enter into a novation agreement as required by Sub-clause 9 (i), the Designer shall have no claim whatsoever against the Employer for any damage, loss or expense howsoever arising out of or in connection with this Warranty.

Except to the extent (if any) expressly permitted by the Consultancy Agreement, the Designer shall not sub-contract any of the Designer's obligations under the Consultancy Agreement without the prior written consent of the Engineer.

10 Without prejudice to its obligations under this Warranty, the Designer shall maintain with well established underwriters of repute and on terms and conditions reasonably acceptable to the Employer, professional indemnity insurance (as per sub-clause 18.5 of the Particular Conditions of Contract) in respect of the Designer and its sub-consultants for Indian Rupees Fifty lakhs (50,00,000 Rupees) in relation to his design of the Works for any one occurrence or series of occurrences arising out of any one event from the date of notification of acceptance until 3 years after the issue of Performance Certificate for the whole of works. The Designer shall immediately inform the Employer if for any reason professional indemnity insurance is not maintained in accordance with this Warranty or becomes void or unenforceable.

11 Insofar as the patent, copyright or other intellectual property rights in any Design Data (as defined in the Contract), plans, calculations, drawings, documents, materials, computer software, know-how and information relating to the Works shall be vested in the Designer, the Designer grants to the Employer his successors and assigns a royalty-free, non-exclusive and irrevocable license (carrying the right to grant sub-licenses) to use and reproduce any of the works designs or inventions incorporated and referred to in such documents or materials and any such know-how and information for all purposes relating to the Works (including without limitation the design, construction, reconstruction, completion, reinstatement, extension, repair and operation of the Works). To the extent beneficial ownership of any such patent, copyright or other intellectual property right is vested in anyone other than the Designer or the Contractor, the Designer shall use his best endeavors to procure that the beneficial owner thereof shall grant a like license to the Employer. Any such license granted shall not be determined if the Designer shall for any reason cease to be employed in connection with the Works.

12 (i) Any dispute or difference of any kind whatsoever between the Employer and the Designer arising under out of or in connection with this Warranty shall be referred to arbitration in accordance with Clause 20 of GC “Dispute” as defined in the Contract

shall be deemed to include any such dispute or difference between the Employer and the Designer.

(ii) In the event that the Employer is of the opinion that the issues in such a dispute or difference will or may touch upon or concern a dispute or difference arising under out of or in connection with the Contract ("the Contract Dispute") then provided that an Arbitrator has not already been appointed, the Employer may by notice in writing to the Designer require and the Designer shall be deemed to have consented to the referral of such dispute or difference to the Arbitrator to whom the Contract Dispute has been or will be referred.

(iii) Save as expressly otherwise provided, the Arbitrator shall have full power to open up, review and revise any decision, opinion, instruction, notice, order, direction, withholding of approval or consent, statement of objection, determination, certificate, assessment or valuation by the Engineer or the Contractor, relating to the dispute or difference.

(iv) This Warranty shall be governed by and construed according to the laws for the time being in force in India and the Designer agrees to submit to the jurisdiction of the courts of Delhi/New Delhi.

IN WITNESS whereof this Warranty has been executed as a deed on the date first before written.

THE COMMON SEAL of

[Designer]

was affixed hereto in

the presence of:-

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Insurance Requirements
[Sub Clause- 18]

Insurance to be taken by the Contractor

In accordance with the provision of GC Clause 18, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, such approval not to be unreasonably withheld.

(A) Insurance of Works and Contractor's equipments-

In accordance with the provision of sub clause 18.2 contractor shall insure to cover loss or damage to works, plants, materials and contractor's documents occurring prior to completion of the facility until the date of issue of the performance certificate.

Amount (in currency(ies))	Deductible limits ((in currency(ies))	Parties insured (names)	From	To
As per GCC/ PCC/Appendix to Tender	-	Contractor and Employer	Commencement Date	Issue of Performance certificate

(B) Insurance against Injuries to Person and Damage to property

Covering any loss, damage, death or bodily injuries which may occur to any physical property or to any person covering loss and damage to Employers property and Employer's personal.

Amount (in currency (ies))	Deductible limits ((in currency (ies))	Parties insured (names)	From	To
As per GCC/ PCC/Appendix to Tender	-	Contractor and Employer	Commencement Date	Issue of Performance certificate

(C) Automobile liability Insurance

Covering use of all vehicle used by the contractors or its sub-contractors (whether or not owned by them) in connection with the design, construction testing and commissioning of the facilities under the contract in accordance with statutory requirements.

(D) Workers' Compensation

In accordance with the statutory requirements applicable in any country where the facilities or any part thereof is executed.

(E) Professional Indemnity Insurance-

To cover professional negligence in the design of the Works.

Amount (in currency (ies))	Deductible limits ((in currency (ies))	Parties insured (names)	From (Place)	To (Place)
As per GCC/ PCC/Appendix to Tender	-	Contractor and Employer	Commencement Date	3 Years beyond defect liability period

Insurance to be taken by the Employer – Nil

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STANDING INDEMNITY BOND FOR 'ON ACCOUNT' PAYMENTS

(On requisite Stamp value)

We, M/s. _____hereby undertake that we held at our stores depots at _____for and on behalf of the Dedicated Freight Corridor Corporation of India Limited acting in the premises through the Managing Director or his Successor_____ here under referred to as 'the Purchaser') all materials for which 'On Account' payments have been made to us against the contract for: DESIGN,SUPPLY, CONSTRUCTION, INSTALATION, OF 2X25 KV ELECTRIFICATION, SIGNALLING AND TELECOMMUNICATION AND ASSOCIATED WORKS INCLUDING TESTING AND COMMISSIONING FOR DOUBLE TRACK ELECTRIFIED RAILWAY LINE ON DESIGN BUILD LUMP SUM BASIS FROM MUGHALSARAI TO NEW SONNAGAR AND CHIRAILAPATHU STATION (EXCLUDING NEW KARWANDIYA- NEW DURGAUTI SECTION) OF EASTERN DEDICATED FREIGHT CORRIDOR.' on _____.DFCCIL also referred to as vide letter no. of Acceptance of Tender No. _____dated _____and materials handed over to us by the Purchaser for the purpose of execution of the said Contract, until such time the materials are duly erected or otherwise handed over to him. We shall be entirely responsible for the safe custody and protection of the said materials against all risk till they are duly delivered as erected equipment to the purchaser, or as he may direct otherwise and shall indemnify the Purchaser against any loss, damage, or deterioration whatsoever in respect of the said materials while in our possession and against disposal of surplus materials. The said materials shall at all times by open to inspection by any officer authorized by the Managing Director, in-charge of the DFCCIL or his successor (Whose address will be intimated in due course).

Should any loss, damage or deterioration of materials occur or surplus materials disposed off and refund becomes due, the Purchase shall be entitled to recover from us the full cost as per prices included in Schedule–A to the Contract (As applicable) and in respect of other materials as indicated in Part 5, Schedule C, D, E & F and also compensation for such loss or damage, if any, along with the amount to be refunded without prejudice to any other remedies available to him by deduction form any sum due or any sum which at any time hereafter become due to us under the said or any other Contract.

Dated this _____day of _____2016

(For and on behalf of)

Messers_____(Contractor)

Signature of Witness

Name of Witness (In Block letters)

Address:

PART – 4

Reference Documents (Separate Booklet)

1. Site Data

a. Formation Alignment (plan & profile)

b. Yard plans

2. Tentative Layout for construction of Transmission Network over EDFC

PART – 5

Price Schedules
(See Separate Booklet)