

(117)

	BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS GROUP Engineering Management Noida																																		
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	CUSTOMER	ONGC HAZIRA																																	
	CONSULTANT	Fichtner Consultants Pvt. Ltd., Mumbai.																																	
	PROJECT	66kV GIS -CCCPP at Hazira plant , Gujarat																																	
TECHNICAL SPECIFICATION CONTENTS																																			
<table border="1"> <thead> <tr> <th>Section No.</th> <th>Description</th> <th>No. of Sheets</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>COVER SHEET</td> <td>1</td> </tr> <tr> <td>1</td> <td>SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES</td> <td>7</td> </tr> <tr> <td>2</td> <td>EQUIPMENT SPECIFICATION:</td> <td>48</td> </tr> <tr> <td>3</td> <td>PROJECT DETAILS GENERAL REQUIREMENTS</td> <td>37</td> </tr> <tr> <td>4</td> <td>GUARANTEED TECHNICAL PARTICULARS</td> <td>24</td> </tr> </tbody> </table>									Section No.	Description	No. of Sheets	0	COVER SHEET	1	1	SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES	7	2	EQUIPMENT SPECIFICATION:	48	3	PROJECT DETAILS GENERAL REQUIREMENTS	37	4	GUARANTEED TECHNICAL PARTICULARS	24									
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4	GUARANTEED TECHNICAL PARTICULARS	24																																	
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SECTION 1**SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES****1.0 SCOPE**

The scope of this specification includes

- 1.1 Design, engineering, manufacturing, testing, demonstration for acceptance, documentation, supply of OPGW and associated hardware & fittings and In-line Splices, transportation, transit insurance and delivery at site and erection of the same on existing 66kV Double Circuit Ichhapore- Hazira line.
- 1.2 Replacing of existing Earth wire by dismantling it on existing 66kV Double Circuit Ichhapore- Hazira line along with its accessories & splices. Earth wire shall be wound on wooden drum. Wooden drum shall be in line with related relevant IS. The earth wire, hardware & accessories shall be credited at the GETCO store as per instruction of Engineer In charge without extra cost to GETCO. Loading, Transportation and unloading from site is also in the scope of bidder without any extra cost to GETCO.

2.0 CUSTOMER / PROJECT DETAIL

Name of customer: ONGC Hazira

Name of the project: 66kV GIS -CCCPP at Hazira plant, Gujarat.

Refer Section - 3 for Project Details and General Specifications.

3.0 QUANTITIES

The quantity for OPGW Cable and along with hardware & accessories is tentative only; and it may change to the order of +20% during detailed engineering at contract stage.

Sl. No.	Item Description	Unit	Quantity
1.	24 Fibre OPGW cable	Km	4
2.	OPGW cable Accessories – Installation Hardware set for 24 fibre OPGW Cable consisting of following:		
i	OPGW Suspension Clamps	Nos.	14**
ii.	OPGW Tension Clamps (Single, with earthing bonds)	Nos.	20**
iii.	OPGW Grounding and Parallel Groove/ Downlead Clamps	Nos.	90**
iv	OPGW Vibration Dampers	Nos.	56**
v	Aarmor Rods for OPGW	Nos.	56**
vi	Way Joint Box for OPGW	Nos.	3**
vii.	24 Fibre Underground armoured fibre optic approach cable	Km	1
viii	Grounding wire with PG Clamps	Set	27
ix	OPGW cable Accessories— Installation hardware set set including ties/clips/cleats, conduits, ducts, supports, fittings, accessories etc. for approach cable	Set	1*
x	OPGW cable Accessories – Indoor-type, Rack-mounted, 24F Fibre Optic Distribution Panel (FODP) including pigtails and FCPC coupling	Nos.	2
3.	Installation of 24F OPGW Cable including Hardware fittings, Jointing, Supervision, Testing Termination, Commissioning etc.	Km	4
4.	Dismantling work of existing earthwire along with accessories & splices etc.at site, loading, transportation, unloading and handing over to GETCO	Lot	1

(115)

Project: 66kV GIS -CCCPP at Hazira plant, Gujarat

Bharat Heavy Electricals Limited

Customer: ONGC Hazira

Doc No. TB-383-510-023

Technical Specification for OPGW Cables along with accessories.

*** Note 1** - One set of installation hardware shall contain all insulation hardware fittings as may be required for 1 Km fibre optic approach cable.

**** Note 2** - The quantity of OPGW cable Accessories have been calculated on the basis of tower spotting data. However, the quantity shall be adjusted as per the actual requirement. Any Other hardware & fittings such as Earthing clamps, download clamps etc. required for installation of OPGW cables shall also be provided as required.

Note 3- Quantity mentioned above is subject to change by $\pm 20\%$ at contract stage.

4. QUALIFYING REQUIREMENT:

Bidder to satisfy all the following requirements.

- 1) OPGW shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned OPGW which must be in satisfactory operation on 220kV system or higher for at least 3 (Three) years as on the date of bid opening . The offered OPGW have to be designed, manufactured and tested as per relevant IS/IEC with latest amendments.
- 2) The minimum requirement of manufacturing capacity of offered type, size and rating of equipment shall be **Seven** times tender/ bid quantity. The Bidder should indicate manufacturing capacity by submitting latest updated certificate of a Chartered Engineer (CE).
- 3) OPGW proposed shall be of similar or higher rating and in service for a minimum period of **THREE (3)** years and satisfactory performance certificate in respect of this is to be available and submitted.
- 4) The Bidder should clearly indicate the quantity and Single Value Contract executed during last **FIVE (5)** years, for the offered equipment. Bidder should have executed one single contract during last five years for the quantity equivalent to tender / bid.
The details are to be submitted in following format,

Sr. No	ITEMS SUPPLIED TO	ORDER REFERENCE No. & DATE	ITEMS	QUANTITY	ORDER FULLY EXECUTED. YES/NO	STATUS, IF ORDER UNDER EXECUTION	REMARK
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5) OPGW offered shall have Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The type test reports shall not be older than **FIVE** years and shall be valid up to expiry of validity of offer.

5. GENERAL REQUIREMENTS:-

This specification defines the design, performance and testing requirements for supply of OPGW cable & its associated hardware & fittings. The Bidder is encouraged to offer standard products and designs. However, the Bidder must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that design information and bill of quantity are provisional only. The Contractor

shall verify the design data during the site surveys for ultimate design & system performance. The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

An analysis of the functional and performance requirements of this specification and/or site survey, design, and engineering may lead the Bidder to conclude that additional items (hardware/software) are required that are not specifically mentioned in this specification.

The

Bidder shall be responsible for providing at no added cost to the Owner i.e. ONGC/BHEL, all such additional items. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items (hardware/software) in their proposal.

OPGW cable & associated hardware & fittings shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electromagnetic interference etc.

The Bidder shall demonstrate a specified level of performance of the OPGW cable & associated hardware & fittings during well structured factory tests.

The bidders are advised to visit sites/routes (at their own expense), prior to the submission of proposal, and make surveys and assessments as deemed necessary for proposal submission.

The successful bidder is required to visit all sites. The site visits/routes shall include all necessary surveys to allow the bidder to perform the design and implementation functions. The bidder shall inform their site/route survey schedule to the Owner well in advance. The site/route survey schedule shall be finalized in consultation with the Owner. The Owner may be associated with the bidder during their site/route survey activities.

After the site/route survey the Bidder shall submit to the Owner a survey report on each link and site. This report shall include at least the following items:

- a. List of all span lengths and the total link length
- b. Suitability for live line installation of OPGW cable on the present infrastructure, Towers etc.
- c. Suitability for off line installation of OPGW cable, if required, on the present Infrastructure, towers etc.
- d. Tower wise identification detail for type with extension for proposed splice locations to be submitted with duly approved by concern engineer in-charge along with

Numbers of fittings & accessories required.

e. Proposed splice locations and cable drum schedules.

f. Proposed routing of the approach cable from the end tower/gantry to the communication room to be marked on the site layout drawing. The existing cable trenches/cable raceways proposed to be used shall be identified. In case suitable existing cable trenches are not available, suitable alternatives shall be suggested.

g. Any other thing to complete the work in Toto.

5.1 General Responsibilities and Obligations

This section describes the general responsibilities and obligations of the Bidder and the Owner.

5.1.1 Responsibilities for the Implementation Plan

The Bidder's technical proposal shall include a project implementation plan and schedule that is consistent with the implementation plan detailed in the technical specification. The Implementation plan shall include the activities of both the Bidder and the Owner, showing all key milestones and clearly identifying the nature of all information and project support expected from the Owner. The Owner and Bidder shall finalize the detailed Implementation plan following award of the contract.

The Bidder shall be responsible for collecting the tower & the transmission line details for the proposed fibre optic links required for cable designing & tower structural analysis. A tower structural analysis shall be carried out by the Bidder to ensure that with the replacement of existing earth wire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Bidder shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exception circumstances, and on Owner specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits.

5.1.2 Bidder Responsibilities and Obligations

The Bidder's obligations include, but are not limited to, the following:

- (1) Provide OPGW cabling that meets the functional and performance requirements of this specification.
- (2) Engineering and design specific to each location including review of, and Conformance with local environmental and earthing requirements.
- (3) Testing and documentation for OPGW cable & its associated hardware & fittings.
- (4) Project management, project scheduling, including monthly project reports documenting Progress during the contract period.
- (5) Studies necessary to identify and provide OPGW cable.
- (6) Suitability for OPGW cable for live line installation.
- (7) Design of the mechanical assemblies and accessories, including vibration dampers required for installation of all overhead fiber cable.

112

- (8) Factory acceptance testing of all equipment provided.
- (9) Conduct type tests and provide documented evidence of satisfactory Type Test Performance to the Owner.
- (10) Provide a Quality Assurance Plan ensuring the Owner access to the manufacturing process (MQP).
- (11) Shipment of all equipment and documentation to the Owner designated locations and/or Staging areas.
- (12) All documentation and drawings as specified.
- (13) Field Quality Plan
- (14) Collection of tower and transmission line details for proposed fiber optic links required for Cable designing and tower structural analysis.
- (15) Sag tension calculation of OPGW to match with the sag tension characteristic of existing earth wire.
- (16) Re analyzing and restrengthening of existing tower for fitment of OPGW if required.
- (17) Bidder has to check the loading of existing tower and accordingly strength the tower peak or increase the height of tower peak.

Detailed descriptions of the Bidder's obligations, in relation to individual items of hardware, software, functions and services, are delineated in other sections of this specification.

5.1.3 The Owner Responsibilities and Obligations

The Owner will provide the following items and services as part of the procurement Project:

- (1) Review and approval of the Bidder's designs, drawings, and recommendations.
- (2) Review and approval of test procedures.
- (3) Participation in and approval of Type test and factory acceptance tests.
- (4) Providing support and access to facilities at the sites.

5.2 General Bidding Requirements

The Bidder shall be responsive to the Owner's technical requirements as set forth in this specification. To be considered responsive, the Bidder's proposal shall include the following

- (1) The Technical Proposal including the documents listed in the table 1-1: Bid Documents Checklist shall be provided in the bid.
- (2) A detailed project implementation plan and schedule that is consistent with the scope of the project and Owner's specified objectives. The plan shall include the activities of both the Bidder and Owner, how all key milestones, and clearly identify the nature of all information and project support to be provided by Owner. Manpower resources proposed to be deployed by the Bidder during the implementation shall be clearly indicated.

(111)

TABLE 1.1			
Bid Documents Checklist			
Sl. No	Description	Enclosure Reference	
1	Type Test Certificates for OPGW cable & its associated hardware & fittings (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no	
2	Completed Data Requirement Sheets (As per relevant Sections of Technical Spec Volume II)	Page no. Ref no	
3	Quality Assurance Program (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no	
4.	Detailed Project Implementation Plan (As per relevant Sections of Technical Specs Volume II)	Page no. Ref no.	

5.3 Organization Of The Technical Specification Document

Sections 2 contains the hardware description and specifications for the fiber optic cable, inspection and test requirements, documentation requirements & project management and implementation requirements.

Appendix A – General requirements, Implementation Schedule and BOQ.

Appendix B – Type test/FAT procedure

6.0 TYPE TEST REQUIREMENTS:

At contract stage, the reports for all type tests shall be submitted for end costumer approval. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited base on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representatives(s) of end costumer or Utility.

The test-reports submitted shall be of the tests conducted within last five years prior to the date of bid opening (date of bid opening is 17/12/2012).

In case the test reports are of the tests conducted earlier than five years from 17.12.2012, the bidder shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable to end costumer due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification on any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

7. INSPECTION, TESTING AND ACCEPTANCE

Bidder has to follow specification and end costumer approved Manufacturing Quality Plan.

8. DEVIATION

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

9.0 APPLICABLE STANDARDS

The following standards and codes shall be generally applicable to the equipment and Works supplied under this Contract:

- (1) American Society for Testing and Materials ASTM-B415, ASTM-D1248, ASTM D 3349.
- (2) ITU-T/CCITT Recommendations G.650, G.652, G.653, G.655.
- (3) Institute of Electrical and Electronics Engineers IEEE-812, 1138-1994, IEEE-524, IEEE-828 & 830 and latest amendment of IEEE 1138.
- (4) Electronic Industries Association, EIA-455-3, 455-31B, 455-32, 455-91, 455-78, 455-59, 455-80, 455-169, 455-81, EIA RS 598
- (5) International Electro technical Commission standards, IEC -1396 and IEC - 1089.
- (6) International Electro technical Commission standards, IEC 793-1, 793-2, 794-1, 794-2, IEC-529, IEC 60794-1-2, IEC 60794-4-10.

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Bidder shall attempt to comply with such, provided that no additional expenses are charged to the Owner without Owner's written consent.

In the event the Bidder offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Bidder shall include with their proposal, full salient characteristics of the new standard for comparison.

10.0 REFERENCES

- (1) CIGRE Guide for Planning of Power Utility Digital Communications Networks
- (2) CIGRE Optical Fibre Planning Guide for Power Utilities
- (3) CIGRE New Opportunities for Optical Fibre Technology in Electricity Utilities
- (4) CIGRE guide to fittings for Optical Cables on Transmission Lines.

~~(4) CIGRE guide to fittings for Optical Cables on Transmission Lines.~~

SECTION 2

Specifications and Functional Description of Fiber Optic Cable

This section describes the functional & technical specifications for supply of OPGW cable & its associated hardware & fittings.

2.1 Fiber Optic Cabling

2.1.1 General

The Bidder shall supply 24 fibre (DWSM) OPGW fibre optic cables. The cable length requirement is indicated in the appendices.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years.

2.1.2 Required Optical Fibre Characteristics

The characteristics of optical fibre to be provided under this specification are as follows.

2.1.2.1 Physical Characteristics

Dual-Window Single mode (DWSM), G.652 telecommunication grade optical fibres shall be provided in fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 2-1(a).

2.1.2.2 Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in Table 2-1(a) shall be "guaranteed" fibre attenuation of any & every fibre reel.

The overall optical fibre path attenuation shall not be more than calculated below.

Maximum attenuation @ 1550nm: $(0.21 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors})$

Maximum attenuation @ 1310nm: $(0.35 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors})$

Table 2-1(a)

DWSM Optical Fibre Characteristics

Fibre Description	Dual-Window Single-Mode
Mode Field Diameter	8.6 to 9.5 μm ($\pm 0.6\mu\text{m}$)
Cladding Diameter	125.0 $\mu\text{m} \pm 1 \mu\text{m}$
Core concentricity error	$\leq 0.6 \mu\text{m}$ at 1310 nm
Cladding non-circularity	$\leq 1 \%$
Cable Cut-off Wavelength λ_{cc}	$\leq 1260 \text{ nm}$
1550 nm loss performance	As per G.652 D
Proof stress Level	$\geq 0.69 \text{ GPa}$
Attenuation Coefficient	@ 1310 nm $\leq 0.35 \text{ dB/km}$ @ 1550 nm $\leq 0.21 \text{ dB/km}$
Attenuation at water peak	$\leq 0.35 \text{ dB/km}$
Chromatic Dispersion Maximum	18 ps/(nm x km) 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
Zero Dispersion Wavelength:	1300 to 1324nm
Zero Dispersion Slope	0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	$\leq 0.2 \text{ ps/km}^{1/2}$
Temperature Dependence	Induced attenuation $\leq 0.05 \text{ dB}$ (-60°C - +85 °C)
Bend Performance	@ 1310 nm (75 $\pm$ 2 mm dia Mandrel), 100 turns; Attenuation Rise $\leq 0.05 \text{ dB/km}$ @ 1550 nm (75 $\pm$ 2 mm dia Mandrel), 100 turns; Attenuation Rise $\leq 0.10 \text{ dB/km}$ @ 1550 nm (32 $\pm$ 0.5 mm dia Mandrel, 1 turn; Attenuation Rise $\leq 0.50 \text{ dB/km}$

2.1.3 Fibre Optic Cable Construction and Link Lengths

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on the 400kV/220 kV/132kV transmission lines spread across Gujarat as specified in Annexure-A. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be Supplied shall be designed to meet the overall requirements of all the transmission lines. The exact details shall be collected by the Contractor during survey. To meet the overall

(107)

requirement of all the transmission lines, the contractor may offer more than one design without any additional cost to GETCO. It may also be noted that some of the transmission lines route may be added during the engineering stage.

The estimated optical fibre link lengths are provided in Annexure-B. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

2. 1.3.1 EHV Transmission Line- Earth wire/Conductor Details

Details of maximum spans, voltage levels and the relevant characteristics of the earth wire/conductor required for design of OPGW cable shall be collected by Bidder.

2.1.3.2 Optical Fibre Identification.

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bell core GR-20 color-coding scheme.

Coloring utilized for color coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The color shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre.

If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

2.1.3.3 Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. Buffer tube (i.e. Steel tube) shall be filled with a water-blocking gel.

2.1.3.4 Optical Fibre Strain

The fibre optic cable shall be designed such that the optical fibres experience no strain under all loading conditions defined in IS 802. No fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of these specifications, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is no fibre strain.
- The no fibre strain condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
- The Cable strain margin is defined as the maximum cable strain at which there is no fibre strain.
- The cable Maximum Allowable Tension (MAT) is defined as the maximum tension experienced by the Cable under the worst case loading condition as defined in IS 802.
- The cable max strain is defined as the maximum strain experienced by the Cable under the worst case loading condition as defined in IS 802.
- The cable Every Day Tension (EDT) is defined as the maximum cable tension on any span under normal conditions viz at 32 °C and no wind.
- The Ultimate /Rated Tensile Strength (UTS/ RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

- 1 The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- 2 The sag shall not exceed the earth wire sag in all conditions.
- 3 The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS of OPGW. However, Max Allowable Tension up to 0.5 times the UTS of OPGW may be accepted, subject to no fibre strain.
- 4 The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- 5 The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart indicating the maximum tension, cable strain and sag shall be calculated for the following conditions as specified in IS 802:1977/1995:

- a. 53 °C, no wind, no ice
- b. 32 °C, no wind, no ice
- c. 0 °C, no wind, no ice
- d. 32 °C, full wind, no ice
- e. 0 °C, 2/3rd / 36% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to max. span length in the range of 50 m spans. The full wind load shall be considered as the design wind load as per relevant IS 802 version and the sag-tension chart shall be submitted accordingly.

2.1.3.5 Cable Materials

(105)

The materials used for optical fibre cable construction, shall meet the following requirements:

2.1.3.5.1 Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC-60794-1-F-5.

The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, non hygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The filling compound shall remain stable for ambient temp. between -20°C and +65°C and shall not drip, flow or leak with age or at high temperatures during short duration lightning strikes and short circuit currents. The filling compound shall meet the requirements of "Seepage of Filling Compound test" as per EIA/TIA 455-81.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

2.1.3.5.2 Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

2.1.3. 5.3 Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in a minimum of 1 cm high white lettering with the vendors' address, the Owner's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number & segment no., factory inspection stamp and date.

(b) Cable Drums : All optical fibre cabling shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied by

the Bidder on each drum shall not be less than 2.5 kms. Same shall be discussed & finalized during the detailed engineering.

2.1.3.6 Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-P 1138, IEEE- 1138-2009 and IEC publication 1396. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose.

The composite fibre optic overhead ground wire shall be made up of **bundled** optical fibre units embedded in a water tight stainless steel protective central **tube** surrounded by concentric-lay stranded metallic wires in single or multiple layers. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

2.1.3.6.1 Central Fibre Optic Unit

The central **Steel tube** shall be designed to house and protect multiple **bundled** optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central **Steel tube** and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

2.1.3.6.2 Basic Construction

The cable construction shall conform to the applicable requirements of this Technical Specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left/right hand lay. However, hardware and accessories shall be suitable to lay direction of OPGW proposed. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed.

2.1.3.6.3 Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

2.1.3.6.4 Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to the electrical & mechanical characteristics of the earth wire being replaced such that there is no or minimal consequential increase in stresses on towers. The existing earth wire parameters are listed in appendices. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable, IS 802:1995 and IS 875: 1987 shall be applied. However the OPGW sag & tension charts shall be based on IS 802. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with their bids.

Table 2.2(a)
OPGW Electrical and Mechanical Requirements

Sr. No.	Parameter	Requirement
1	Everyday tension at 32 deg. C, no wind	$\leq 20\%$ of UTS of OPGW
2	D.C. Resistance at 20 deg. C	$< 1 \text{ Ohm/Km}$ (Tolerance + 10 %)
3	Short Circuit Current	$\geq 6.32 \text{ KA}$ for 1 sec

2.1.3.6.5 Operating conditions

Since OPGW shall be located at the top of the EHV transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be the same or similar as those required of conventional ground wire.

2.1.3.6.6 Live Line Installation Suitability

OPGW shall be suitable for installation under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE guide to the installation of overhead transmission line conductor (IEE STD.524 with latest revisions), with additional instructions and precaution for live line working and fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing.

A tower structural analysis shall be carried out by the Contractor, based on the relevant data to be provided by Owner, to ensure that with the replacement of existing earthwire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Contractor shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on Owner specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

2.1.3.6.7 Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Down lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation min. @1% shall also be provided as part of set/km. for each transmission line without any additional cost to GETCO. The Bidder shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The Bidder shall provide the OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document for all the assemblies & components. However, DRS format of assemblies has been enclosed in the appendices. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminum alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a minimum vertical load not less than 70% of UTS of OPGW. The suspension clamps slippage shall occur between 8% and 15% of UTS of OPGW as measured in accordance with type test procedures specified in appendix B, Vol. IIC.

The Bidder shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW).

(b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of the performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the

inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth, shall be used for suspension and tension points in each span. The Bidder shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in appendices. Vibration damper clamps shall be made of aluminium or aluminium alloy shall support the dampers during installation and shall maintain the dampers in position without damage to the OPGW and without causing fatigue. Armour or patch rods made of aluminium or aluminium alloy shall be provided as required to reduce clamping stress on the OPGW. The vibration damper body shall be hot-dip galvanized mild steel/cast iron or shall be permanent mould cast zinc alloy.

2.1.4 In-Line Fibre Optic Splice Enclosures and Optical fibre Splices

All in-line splices shall be encased in In-Line Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. In line splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of a minimum of 48/24 optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. In-line splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 meters from the ground level and shall accommodate pass through splicing. The bidder shall be responsible for splicing of fibres and installation of splice enclosures.

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures.

All optical fibre splicing shall comply with the following:

- (a) All fibre splices shall be accomplished through fusion splicing.
- (b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.
- (c) All splices and bare fibre shall be neatly installed in covered splice trays. No more than six (6) fibres shall be installed in each splice tray.
- (d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.
- (e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

2.1.5. Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the armoured underground fibre optic cable required to connect Overhead Fiber Optic Cable (OPGW) between the final in line splice enclosure on the gantry/tower forming the termination of

the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length shall be decided during site survey or Detailed Engineering. However, the Bidder shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Bidder during the project execution and the Contract price shall be adjusted accordingly.

2.1.5.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

2.1.5.2 Jacket Construction & Material

The approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

2.1.5.3 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

2.1.5.4 Installation of Approach Cable

A network of cable trenches and/or ducts may exist at some sites but shall require expansion and/or new construction at most stations. It shall be a responsibility of the Bidder to cooperate fully with the Owner and all other on-going project Bidders in the planning and efficient use of existing and new-construction infrastructure supporting on-station communications cabling. The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Bidder shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be proposed for Owner approval. However, the approach cable shall be laid in the HDPE pipe in all conditions. The Owner shall provide any additional outdoor cable raceways and/or cable trenches required for such approved alternatives.

It may be noted that in order to utilise the existing trenches, the approach cable may be required to be co-located with HV and LV cables. Accordingly, the approach cable shall be installed in corrosion resistant flexible conduit. Suitable provisions shall be made by the Bidder to ensure adequate safety earthing and insulated protection for the approach cable.

Approach cables exiting from the ground or passing through floors shall be protected against mechanical damage.

Approach cables shall penetrate buildings through cable ducts. The cabling shall route within buildings in cable raceways or under raised floors. The Bidder may utilize existing ducts, building penetrations, cable trays, racks, etc., where appropriate and approved by the Owner.

The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals.

On short approach cable runs for which cable supports are not required, the Bidder shall fix the cable to the structure of the building using approved fixings and cable cleats.

The Bidder shall be responsible for new building penetrations required for approach cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetrations shall be neatly formed and sealed for protection from moisture, dust, wind and vermin intrusion.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for lay and installation of approach cables shall be supplied and installed by the Bidder.

2.1.6 Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Bidder shall provide rack mounted Fibre Optic Distribution Panels (FODPs) and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed at the time of detailed engineering.

2.1.6.1 Fibre Optic Distribution Panels

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

- (a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.
- (b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.
- (c) FODPs for indoor use shall be supplied in suitable cabinets or racks with locking arrangements.
- (d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Specific selection of the entry points shall be made at the time of installation. Ground lugs shall be provided on all FODPs and the Bidder shall ensure that all FODPs are properly grounded. The FODP for outdoor installation shall meet or exceed ingress protection class IP66 specifications and shall be suitable for tower mounting. The FODP for indoor installation shall meet or exceed ingress protection class IP55 specifications.

2.1.6.2 Optical Fibre Connectors

Optical fibres shall be connectorized with FC-PC, LC or any other better connector decided in detailed Engineering. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

2.1.7 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops:

In-line splice enclosures installed outdoors and mounted on the utility towers shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Indoor Cable Service Loops:

FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius is maintained.

(c) Fibre Units Service Loops:

For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops:

Connectorized pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(e) Fibre Service Loops:

At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

2.1.8 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Owner for review and approval in the engineering/design phase of the project, prior to

establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to Owner for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification. The maximum allowable stringing tension, maximum allowable torsion shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to Owner in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Bidder. The Bidder shall supply all tools & accessories required for installation. It shall be the Bidders responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

Inspection & testing requirements

This section describes the specific requirements for inspection & testing requirement for supply of OPGW cable & its associated hardware & fittings.

3.1 General

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Owner.

The entire cost of testing for factory acceptance test, routine tests, production tests and other test during manufacture specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Owner's representative. Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Bidder as necessary to correct the noted deficiencies at no cost to the Owner. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test shall be considered complete when (a) all variances have been resolved (b) all the test records have been submitted (c) Owner acknowledges in writing the successful completion of the test.

3.1.1 Inspection

Access to the Bidder's facilities while manufacturing and testing are taking place, and to any facility where systems/equipment are being produced/tested for Owner shall be available to Owner representatives. The Bidder shall provide to Owner representatives sufficient facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification. Inspection rights shall apply to the Bidder's facilities and to sub-Bidder facilities where equipment is being manufactured.

Inspections will be performed by Owner, which will include visual examination of hardware, enclosure cable dressings, and equipment and cable labeling. Bidder documentation will also be examined to verify that it adequately identifies and describes all wiring, hardware and spare parts. Access to inspect the Bidder's hardware quality assurance standards, procedures, and records that are applicable to the facilities shall be provided to Owner.

3.1.2 Inspection Certificate

The Bidder shall give the Owner two weeks in case of domestic supplies and six weeks in case of foreign supplies written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector. The Owner, unless witnessing of the tests is waived, will attend such tests on the scheduled date for which Owner has been so

notified or on a mutually agreed alternative date. If Owner fails to attend the testing on the mutually agreed date, Bidder may proceed with the test which shall be deemed to have been made in the Inspector's presence and Bidder shall forthwith forward to the Inspector, duly certified copies of the test results in triplicate.

The Owner shall, within fourteen (14) days from the date of inspection as defined herein, give notice in writing to the Bidder of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Bidder shall give due consideration to such objections and shall make the modifications that may be necessary to meet said objections. When the factory tests have been completed successfully at the Bidder's or Sub-Bidder's works, the Owner shall issue a certificate to this effect within fourteen (14) days after completion of tests but if the tests are not witnessed by the Owner, the certificate shall be issued within fourteen (14) days of receipt of the Bidder's Test Certificate by the Owner. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

In cases where the Contract provides for tests, whether at the premises or works of the Bidder or of any Sub-Bidder, the Bidder except where otherwise specified shall provide free of charge items such as labour, materials, electricity, fuel, water stores, apparatus and instruments, as may be reasonably demanded by the Owner or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall provide facilities to the Owner or his authorized representative to accomplish testing.

The inspection by Owner and issue of Inspection Certificate thereon, shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Program forming a part of the Contract.

The Bidder shall keep the Owner informed in advance of the time of starting of the progress of manufacture of material in its various stages so that arrangements can be made for inspection.

Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection by the Owner's representative.

Certificates of manufacturing tests shall be maintained by the Bidder and produced for verification as and when desired by the Owner. No material shall be dispatched from its point of manufacture until it has been satisfactorily inspected and tested. Testing shall always be carried out while the inspection may be waived off by the Owner in writing only.

However, such inspection by the Owner's representative(s) shall not relieve the Bidder from the responsibility for furnishing material, software, and equipment to conform to the requirements of the Contract; nor invalidate any claim which the Owner may make because of defective or unsatisfactory material, software or equipment.

3.1.3 Reporting of Variance

A variance report shall be prepared by either Owner or Bidder personnel each time a deviation from specification requirements is detected during inspection or testing. All such variances shall be closed in mutually agreed manner.

However, at any stage if Owner feels that quality of variances calls for suspension of the testing the testing shall be halted till satisfactory resolution of variances, which may involve retesting also.

3.2 Test Plans and Procedures

Test plans for factory acceptance tests shall be provided by the Bidder to ensure that each test is comprehensive and verifies all the features of the equipment are tested. The test plans for factory tests shall be submitted for Owner approval before the start of testing.

The Bidder shall prepare detail testing procedure in line to specification and submit for Owner's approval. The procedure shall be modular to the extent possible, which shall facilitate the completion of the testing in the least possible time.

3.2.1 Test Records

The complete record of all factory acceptance tests results shall be maintained by the Bidder. The records shall be maintained in a logical form and shall contain all the relevant information. The test reports shall be signed by the testing engineer and the engineer witnessing the tests.

3.3 Testing Requirements

Following are the requirements of testing for supply of OPGW Cable:

1. Type Testing
2. Factory Acceptance Testing

3.3.1 Type Testing

The Bidder shall submit the complete type test reports as stated in Appendix -B for the offered item along with the offer **otherwise the offer shall be liable to be rejected**. These tests must have been conducted in NABL approved laboratory within last 5 years prior to date of validation of the offer.

3.3.2 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of a Fibre Optic Cable & associated hardware & accessories to be supplied. Factory acceptance testing shall be carried out on overhead fibre optic cable (OPGW) & FO cable hardware fittings & accessories splice enclosures and all other items.

Equipment shall not be shipped to the Owner until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Owner, and the Owner has issued Material Dispatch & Clearance Certificate (MDCC). Successful completion of the factory tests and the Owner approval to ship shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Owner's authorized representatives unless waiver for witnessing by Owner's representatives is intimated to the Bidder.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation in this Section by the Owner.

The factory acceptance test shall demonstrate the technical characteristics of the Fibre Optic cable & associated accessories in relation to this specifications and approved drawings and documents. List of factory acceptance tests for OPGW and FO cable hardware fittings & accessories are given in Appendix B. This list of factory acceptance tests shall be supplemented by the Bidder's standard FAT testing program. The factory acceptance tests for the splice enclosures shall be proposed by the Bidder in accordance with technical specifications (mentioned in Appendix-B) and Bidder's (including Sub-Bidder's / supplier's) standard FAT testing program.

3.3.2.1 Sampling for FAT

From each batch of equipment presented by the Bidder for Factory acceptance testing, the Owner shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. Physical inspection shall be carried out on 100% basis for all the equipment/items offered.

For the FO cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Owner reserves the right to require the Bidder to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

3.3.2.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Bidder to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Bidder's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Owner. However, the Owner reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

DOCUMENTATION AND DELIVERABLES

This section describes the documentation requirements and provides a list of deliverable that the Bidder shall provide to Owner.

The Bidder shall submit a comprehensive list of the document as applicable for the offered system for Owner's approval immediately after signing of the Contract and the documents shall be finalized as per the approved list. The Schedule for submission/approval of documents shall be in line with overall project schedule.

4.1 Documentation

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Bidder shall submit documentation describing the systems to Owner for review and approval. Further the Bidder shall also submit the drawings/documents for testing of the system. The Bidder shall obtain approval of Owner for the relevant document at each stage before proceeding for purchase, manufacturing, factory testing etc.

Each document shall be identified by a Bidder document number, the Owner document number, and the Owner purchase order number. Where a document is revised for any reason, each revision shall be indicated by a number, date, and description in a revision block along with an indication of official approval by the Bidder's Project Manager. Each revision of a document shall highlight all changes made since the previous revision.

The Bidder shall submit three hard copies of each document/drawing for Owner's review and approval along with soft copy with each submission. After approval two set of all the documents/drawings shall be submitted as final documentation, however, for site specific documents two sets of documents shall be provided for each site. In addition to paper copies all the documents shall also be provided on electronic media in two copies. In case any documentation requirement is specified in the relevant section the same shall apply for the equipment /system defined in that section. The following document shall be submitted as applicable for the subsystem.

- (a) Data Requirement sheets
- (b) Sag tension charts
- (c) Bill of Quantity
- (d) Standard documents
- (e) Previous type test report
- (f) Manufacturing Quality Plan
- (g) Test Procedure (Type test & FAT)
- (h) Test report (Type test & FAT)
- (i) Test Schedule
- (j) Transportation & handling procedure
- (k) Numbering, Marking, labeling document

The documentation pertaining to third party or OEM products may be supplied in the format as available from the third party/OEM. If both formats (Paper/electronic) are available then the

above mentioned copies of documents shall be supplied in both the formats, however, in exceptional cases where the Bidder is not able to get more copies due to copyright laws restriction, the issue will be mutually agreed upon on case to case basis. The document to be submitted shall include the following:

4.1 System Functional Description Document

The document shall include an overview of the system configuration. This document shall be designed to serve as a complete introduction to the supplied system and to the more specific documents that are defined in this Section. The document shall be oriented to the Owner user's point of view and be subject to the Owner's review and approval. Users will include Owner operating personnel communication support staff and maintenance personnel.

4.2 Test Documentation

The Bidder shall provide documentation for all type tests and factory tests & field tests. The test documentation shall include the following:

- (a) Type test documents (Procedures & Reports)
- (b) Factory Acceptance Test Documents (Procedures & Reports)
- (c) Site Acceptance Test Documents (Procedures & Reports)

4.3 Drawings

All drawings submitted by the Bidder shall indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications. Each drawing submitted by the Bidder shall be clearly marked with the Owner name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (e.g.: originator, checker and approving authority).

90



Project Management, Schedule and Implementation Plan

This section describes the project management, schedule, quality assurance and implementation plan requirements for the supply of OPGW Cable & associated hardware and fittings.

5.1 Project Management

The Bidder shall assign a Project Manager with the authority to make commitments and decisions that are binding on the Bidder. The Project Manager's responsibility shall include interface and coordination with the Project Bidder. The Owner will designate a Project Manager to coordinate all the Owner project activities. All communications between the Owner and the Bidder shall be coordinated through the Project Managers.

5.2 Project Review Meetings

Progress meetings shall be scheduled by the Project Manager and attended by the Bidder and Owner each reporting period to review progress of the project. Progress meetings shall be used to review the progress report, written correspondence exchanged since the last meeting, and open action items.

The Bidder shall also attend technical meetings as required to discuss technical aspects of the project and to review Owner comments on approval documents. When appropriate, these technical meetings shall be conducted as extensions to the progress meetings. The consultant shall also attend the meeting as and when required by Owner. The Project Manager shall schedule and attend Progress Meetings as deemed necessary but no less than once every months.

5.3 Progress Report

A progress report shall be prepared by the Bidder each month against the activities listed in the project schedule. The report shall be made available to Owner on a monthly basis, e.g., the 10th of each month. The progress report shall include all the completed, ongoing and scheduled activities and transmittals issued and received for the month.

5.3 Transmittals

Every document, letter, progress report, change order, and any other written exchanged between Bidders and the Owner shall be assigned a unique transmittal number. The Bidder shall maintain a correspondence index and assign transmittal numbers consecutively for all Bidder documents. The Owner will maintain a similar correspondence numbering scheme identifying documents and correspondence that the Owner initiates.

5.4 Quality Assurance and Quality Control Program

All materials and parts of the system/sub-system to be supplied under the project shall be of current manufacture from a supplier regularly engaged in the production of such equipment.

The Bidder shall maintain a Quality Assurance/Quality Control (QA/QC) program that provides that equipment, materials and services under this specification whether manufactured, designed or performed within the Bidder's plant, in the field, or at any sub-Bidder source shall be controlled at all points necessary to assure conformance to contractual requirements. The program shall provide for prevention and ready detection of discrepancies and for timely and positive corrective action. The Bidder shall make objective evidence of quality conformance readily available to the Owner. Instructions and records for quality assurance shall be controlled and maintained at the system levels. The Bidder shall describe his QA/QC program in the Technical Proposal, (along with samples from his QA/QC manual) and shall submit his QA/QC Manual for review and acceptance by the Owner.

Such QA/QC program shall be outlined by the Bidder and shall be finally accepted by Owner after discussions before the award of Contract. A Quality Assurance Program of the Bidder shall generally cover but not be limited to the following:

- (a) The organization structure for the management and implementation of the proposed Quality Assurance Program.
- (b) Documentation control system.
- (c) Qualification data for key personnel.
- (d) The procedure for purchase of materials, parts/components and selection of sub Bidder's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases, etc.
- (e) System for shop manufacturing including process controls.
- (f) Control of non-conforming items and system for corrective action.
- (g) Control of calibration and testing of measuring and testing equipments.
- (h) Inspection and test procedure for manufacture.
- (i) System for indication and appraisal of inspection status.
- (j) System for quality audits.
- (k) System for authorizing release of manufactured product to Owner.
- (l) System for maintenance of records.
- (m) System for handling, storage and delivery.
- (n) A Quality Plan detailing out the specific quality control procedure adopted for Controlling the quality characteristics of the product.

The Quality Plan shall be mutually discussed and approved by the Owner after incorporating necessary corrections by the Bidder as may be required. Neither the enforcement of QA/QC procedures nor the correction of work mandated by those procedures shall be cause for an excusable delay. An effective Quality Assurance and Quality Control organization shall be maintained by the Bidder for at least the duration of this Contract. The personnel performing QA/QC functions shall have well defined responsibility, authority, and organizational freedom to identify and evaluate quality problems and to initiate, recommend, or provide solutions during all phases of the Contract. The QA/QC organization of the Bidder shall be an independent administrative and functional structure reporting via its manager to the Bidder's top management. The QA/QC manager(s) shall have the authority within the delegated areas of responsibility to resolve all matters pertaining to quality to the satisfaction of Owner when actual quality deviates from that stated in the Work Statement.

The Bidder shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Owner's inspection of equipment/materials.

The Owner or his duly authorized representative reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Bidder's/his vendor's Quality Management and Control Activities.

The scope of the duties of the Owner, pursuant to the Contract, will include but not be limited to the following:

- (a) Review of all the Bidder's drawings, engineering data etc.
- (b) Witness or authorize his representative to witness tests at the manufacturer's Works or at site, or at any place where work is performed under the Contract.
- (c) Inspect, accept or reject any equipment, material and work under the Contract in accordance with the specifications.
- (d) Issue certificate of acceptance and/or progressive payment and final payment certificate
- (e) Review and suggest modification and improvement in completion schedules from time to time; and
- (f) Monitor the Quality Assurance program implementation at all stages of the works.

5.6 Project Schedule

The project implementation plan is given in Appendix - A. Based upon this the Bidder shall submit a preliminary project implementation schedule along with the bid. The detail project implementation schedule shall be submitted by the Bidder after award for Owner's approval, which shall include at least the following activities:

- (a) Documents, DRS, Drawing submission and approval
- (b) Type Testing Schedule
- (c) Manufacturing
- (d) Factory Testing Schedule
- (e) Dispatch Schedule
- (f) Receipt & Storage

The project implementation schedule shall include the estimated period for completion and its linkage with other activities. The Project implementation schedule shall also contain Owner activities required for the Bidder to complete the system.

5.7 Implementation Schedule

Appendix A of this Technical Specifications provides a implementation schedule for the supply of OPGW Cabling.

The Bidder shall submit a detailed project schedule showing the activities of both the Bidder and Owner and also including the documentation schedule and training schedule. The Owner and the Bidder shall finalize the detailed implementation plan following the award of the contract.

APPENDIX A**GENERAL REQUIREMENTS, IMPLEMENTATION SCHEDULE & BILL OF QUANTITIES****Table-1
Details of Tower/Earth wire/Conductor**

Sl. No	Volt (KV)	Every Day Temp. (as per design)(°C)		Details of Earth wire Conductor				Ground Fault Current (KA)
		Conductor	E/wire	Size (mm)	UTS (KN)	Weight (Kg/Km)	Overall diameter (mm)	
1	400KV	35	35	7/3.66	72.9	575	10.98	40
2	220KV / 66KV	35	35	7/3.15	56	428	9.45	40/31.5

Table 2: BOQ for OPGW & associated Hardwares

Sl. No.	Item Description	Unit	Quantity
1	24 Fibre (DWSM) OPGW fibre optic cable.	Km.	As specified in BOQ
2	Installation Hardware set* for above OPGW i.e. all Cable fittings & accessories like suspension clamps, tension clamps, vibration dampers, earthing clamps, down lead clamps, in-line splice enclosures etc.	Set*	
3	Fibre Optic Approach Cabling (DWSM 24F) including installation hardware like ties/clips/cleats, conduits, ducts, supports, fittings, accessories etc for extending OPGW from sub-station end tower/gantry to FODP at control/communication room by splicing fibres of OPGW with FOAC in joint box at tower/gantry and splicing FOAC in FODP at control/communication room.	Meter	

Note: (*)

- 1) One set of installation hardware shall contain all installation hardware fittings as may be required for 1 km of OPGW cabling.
- 2) Hardwares set shall be supplied as per approved drawing during detailed engineering.

Table- 3
Type testing requirement

Sl. No.	Item Description	Unit
1	Type tests for Optical Fibres	1
2	Type tests for OPGW cable	1
3	Type tests for OPGW cable fittings	1
4	Type tests for in line splice enclosure	1

Appendix -B
TYPE TESTING/ FACTORY ACCEPTANCE TESTS REQUIREMENTS

Wherever the referenced test procedures or the technical specifications call for visual inspection for damage, the test report shall include a full description of observed status of the sample. (Visually inspected samples shall also be colour photographed and copies of colour photographs shall be included in type test report).

B-1 Type Tests for Optical Fibres

The type tests listed below in table B-1.1 shall be conducted on DWSM fibres. The tests specific to the cable type are listed in subsequent sections.

Table B-1.1
Type Tests For Optical Fibres

Sl. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Attenuation Variation with Wavelength	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
3	Attenuation at Water Peak	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
4	Temp. Cycling (Temp dependence of Attenuation)		EIA/TIA 455- 3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		EIA/TIA 455- 62A
6	Mode Field dia.		EIA/TIA 455- 164A/167A/174
7	Chromatic Dispersion		EIA/TIA 455- 168A/169A/175A
8	Cladding Diameter		EIA/TIA 455-176
9	Point Discontinuities of attenuation		EIA/TIA 455-59
10	Core -Clad concentricity error		EIA/TIA 455-176
11	Fibre Tensile Proof Testing		EIA/TIA 455-31B

(84)

B-2 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in table B-2.1: Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table B-2.1 Type tests for OPGW Cable

Sl. NO.	Test Name	Test Description	Test Procedure	
1	Water Ingress Test	IEEE 1138 Section 4.1.1.1	IEEE 1138, Section 5.1.1.1 (IEC 794-1-F5 /EIA/TIA 455-82B) : Test duration : 24 hours	
2	Seepage of filling compound	IEEE 1138 Section 4.1.1.2	IEEE 1138 Section 5.1.1.2 (EIA/TIA 455-81B)	Preconditioning period : 72 hours. Test duration : 24 hours.
3	Short Circuit Test	Section 4.1.1.3 Or	IEEE 1138 Section 5.1.1.3	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. A suitable temperature sensor such as thermocouple shall be used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand as required by IEEE 1138. Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
		IEC 60794-1-2(2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature. However, maximum temperature recorded on any component of OPGW cable shall not exceed the Short Circuit transient peak temperature guaranteed by the Bidder during design.
4	Aeolian Vibration Test	IEEE 1138 Section 4.1.1.4	IEEE 1138 Section 5.1.1.4	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The vibration frequency and amplitude shall be monitored and recorded continuously. All fibres of the test cable sample shall be spliced together in

(83)

				serial for attenuation monitoring. Test shall be conducted with tension / suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
5	Galloping test	IEEE 1138 Section 4.1.1.5	IEEE 1138 Section 5.1.1.5	Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring
6	Cable Bend Test	Procedure 2 in IEC:794-1-E11		The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC:794-1-E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping.
7	Sheave Test	IEEE 1138 Section 4.1.1.6 Or IEC 60794-1-2 (2003) Method E18B	IEEE 1138 Section 5.1.1.6	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The Sheave dia. Shall be based on the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
8	Crush Test	IEEE 1138 Section 4.1.1.7	IEEE 1138 Section 5.1.1.7 (IEC 794-1-E3/ EIA/TIA 455-41B)	The crush test shall be carried out on a sample of approximately one (1) metre long in accordance with IEC:794-1-E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.
9	Impact Test	IEEE 1138 Section 4.1.1.7	IEEE 1138, Section 5.1.1.7 (IEC 794-1-E4/ EIA/TIA 455-25B)	The impact test shall be carried out in accordance with IEC:794-1-E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate

				piece shall be the reel drum radius $\pm$ 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.
10	Creep Test	IEEE 1138 Section 4.1.1.8	IEEE 1138 Section 5.1.1.8	As per Aluminium Association Method , the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain margin limits shall also be calculated.
11	Fibre Strain Test	IEEE 1138 Section 4.1.1.9	IEEE 1138 Section 5.1.1.9	
12	Strain Margin Test	IEEE 1138 Section 4.1.1.10	IEEE 1138 Section 5.1.1.10	
13	Stress strain Test	IEEE 1138 Section 4.1.1.11	IEEE 1138 Section 5.1.1.11	
14	Cable Cut-off wavelength Test	IEEE 1138 Section 4.1.1.12	IEEE 1138 Section 5.1.1.12	
15	Temperature Cycling Test	IEEE 1138 Section 4.1.1.13	IEEE 1138 Section 5.1.1.13	
16	Corrosion (Salt Spray) Test	EIA/TIA 455-16A		
17	Tensile Performance Test	IEC 794-1-E1 / EIA/TIA 455-33A	The test shall be conducted on a sample of sufficient length in accordance with IEC:794-1-E1. The attenuation variation shall not exceed 0.05 dB/km up to 90% of RTS of fibre optic cable. The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded.	
18	Fault Current/ lightning Test	IEEE Std. 4-1978 or	Tension equal to 20% of the OPGW RTS shall be applied to a sample with minimum length of 15 m of cabled fibres and two separate 4/10 micro second current impulses each having a peak value of 150 KA and a negative polarity shall be applied through a 1 cm gap. The attenuation during the tests shall be continuously measured. After the tests the same shall be visually inspected. Any increase in optical waveguide fibres attenuation measured at 1550 nm shall constitute failure. Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The tensile performance test shall be repeated on the sample subjected to the lightning arc test.	

(81)

		IEC 60794-1-2(2003)	The cable construction shall be tested in accordance with Method H2
19	DC Resistance Test	On a fibre optic cable sample of minimum 1 meter length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.	

B-3 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed Below.

B-3.1 Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards : IS : 2486 / IEC : 61284 :1997.

1. Suspension Assembly

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16°. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:

The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

2. Tension Assembly

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held

for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then removed in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made and any evidence of visual deformation shall be documented.

Part 2:

The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during

Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

B-3.2 Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 8% of UTS of OPGW at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative position between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 15% of UTS of OPGW. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met:

79

- No slippage* shall occur at or below the specified minimum slip load.

*Definition of no slippage in accordance with IEC 61284:1997:-

Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

- Slippage shall occur between the specified maximum and minimum slip load of 8 to 15% of UTS of OPGW.
- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.
- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum and maximum slip, shall be considered as slip.
- The Armour Rods shall not be displaced from their original lay or damaged**.

** Definition of no damage in accordance with convention expressed in IEC 61284 : 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

B-3.3 Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on a 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20 % of the RTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead -End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

* Definition of no movement as defined in IEC 61284 : Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.

(75)

B-3.4 Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kg-m or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial calipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

B-3.5 Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

B-3.6 Type Test on Vibration Damper

B-3.6.1 Dynamic Characteristic Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band as determined through vibration analysis of undamped OPGW. The damper assembly shall be vibrated vertically with a ± 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

- (a) Force Vs frequency
- (b) Phase angle Vs frequency
- (c) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

The above dynamic characteristics test shall be conducted on five dampers. The variations between the samples tested shall conform to the sample test limits.

B-3.6.2 Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

- (d) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as max Permissible Every Day Tension (20% of UTS), for a span ranging from 100 m to 1100 m.
- (e) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.
- (f) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
- (g) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.
- (h) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

B-3.7 Vibration Damper Clamp Slip and Fatigue Tests**B-3.7.1 Test Set Up**

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 15 kN and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

B-3.7.2 Clamp Slip Test

The vibration damper shall be installed on the test span. The damper clamp, after tightening with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of fibre optic cable for a minimum duration of one minute shall not slip, i.e., the permanent displacement between fibre optic cable and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased until the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

B-3.7.3 Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than $\pm 25/f$ mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein above shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

- (i) There shall not be any frequency shift by more than ± 2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.
- (j) The force response curve shall generally lie within guaranteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Supplier.
- (k) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Supplier. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

B-4 Type Tests for In Line Splice Enclosures

Following Type tests shall be demonstrated on the In Line Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 794-1 procedures).

B-4.1 Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to $+65^{\circ}\text{C}$ with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20/ IEC 794-1- C10. The variation in attenuation shall be less than $\pm 0.05\text{dB}$. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

B-4.2 Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of $+55^{\circ}\text{C} \pm 2^{\circ}\text{C}$ with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than $\pm 0.05\text{dB}$, and the internal humidity rate measured, less than 2% .

B-4.3 Rain Withstand Test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60 testing requirements. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than $\pm 0.05\text{dB}$.

B-4.4 Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than $\pm 0.05\text{dB}$. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

B-4.5 Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

- a) 3 torsion cycles of $\pm 180^{\circ}$ shall be exercised on the cable. Each cycle shall be less

than one minute.

- b) 3 flexure cycles of the cable, of $\pm 180^\circ$ with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than $\pm 0.05\text{dB}$. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure.

B-4.6 Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

B-4.7 Drop Test

With 2 lengths of 10 meters of cable fixed to the box, it shall be dropped five times from a height of 11 meters. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test shall be carried out in accordance with procedure described in IEC-68-2-32.

B- 5 Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in Table 3-6: Type Tests for Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table B-5
Type Tests for Approach Cable

Sl. No	Test Name	Test Procedure
1	Water Ingress Test	IEC 794-1-F5/EIA 455-82B
2	Seepage of filling compound	EIA 455-81A
3	Crush Test	IEC 794-1-E3/EIA 455-41
4	Impact Test	IEC-794-1-E4/EIA 455-41
5	Stress strain Test	EIA 455-33A
6	Cable Cut-off wavelength Test	EIA-455-25A
7	Temperature Cycling Test	IEC794-1-F1/EIA-455-3A

B- 5.1 Impact Test

The Impact test shall be carried out in accordance with IEC: 794-1-E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius $\pm$

10%. A permanent or temporary increase in optical attenuation value greater than 0.05 dB/km shall constitute failure.

B-6 Factory Acceptance Tests On Fibre Optic Cables

As specified in technical specifications, the Factory acceptance tests shall be conducted on random sampling of fibre optic cable to be supplied for the present procurement, prior to any shipment.

B-6.1 FAT on Fibre: Optical Acceptance Tests

The Optical acceptance tests listed in table B-5.1 below are applicable for the fibres of all types of Fibre Optic Cables i.e. OPGW and approach cable to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138 section 4.2.2.1 and section 5.2.2.1. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

Table B-6.1

Factory Acceptance Tests for Fibres of all FO cables: Optical Tests

Sl. No	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation		EIA/TIA 455-59
3	Attenuation at Water Peak		EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B

The test reports for the above tests for all types of the fibres carried out by the Fibre Manufacturer and used in the OPGW cables and approach cable shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

B-6.2 Factory Acceptance Test On OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table B-5.2 follow the requirements set forth in section 4.1.2 and section 5.1.2 of IEEE standard 1138. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

Table B-6.2
Factory Acceptance Tests On OPGW
Applicable standard: IEEE 1138

Sl. No	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

B-6.3 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table B-5.3. The sampling plan shall be as per IS 2486:

Table B-6.3

Factory Acceptance Tests On OPGW Fittings

Sl. No.	Factory Acceptance Test
Suspension Assembly	
1	UTS/Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Mechanical strength of each component Tension Assembly
Tension assembly	
5	Clamp Slip Strength test
6	Visual Material verification and dimensional checks as per approved DRS/Drawings
7	Mechanical strength of each component Vibration Damper
Vibration Damper	
8	Galvanizing test on damper, masses and messenger wires

9	Damper response (resonant frequencies)
10	Clamp Slip test
11	Strength of messenger wires
12	Mass pull off test
13	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
14	Clamp fit test
15	Clamp Strength test
16	Visual Material verification and dimensional checks as per approved DRS/Drawings

B-6.4 Factory Acceptance Test on In Line Splice Enclosures

The factory acceptance tests for In Line Splice Enclosures as specified below in Table B-5.4:

Table B-6.4
Factory Acceptance Tests on In Line Splice Enclosures (Joint box)/FODP

SI No.	Factory Acceptance Test
1	Visual check Kit Quantities and Specific Component Number for each component of In Line Splice Enclosure and dimensional checks against the approved drawings.

B – 6.5 Factory Acceptance Test On Approach Cable

The factory acceptance tests for Approach Cable specified below in Table 6.5:

Table B-6.5
Factory Acceptance Tests On Approach Cable

SI. No.	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550 and Water Peak)
2	Point discontinuities of attenuation
3	Chromatic Dispersion
4	Visual Material verification and dimensional checks as per approved drawings

B- 6.6 Factory Acceptance Tests on Test Equipment, pigtail & other

As per technical specification and approved DRS/Documents.

B – 6.7 Site Acceptance Tests

The Bidder shall be responsible for the submission of all equipment including Test equipment supplied in this contract for site tests and inspection as required by the Owner. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. A minimum Site Acceptance Testing requirement for FO cables is outlined in following section. This testing shall be supplemented by the Bidder's standard installation testing program, which shall be in accordance with his quality plan(s) for FO cabling installation.

During the course of installation, the Owner shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Owner to demonstrate that it is entirely suitable for commercial operation.

6.7.1 Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

6.7.2 Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links. **Test results shall be recorded in formats enclosed at the end of this specification for tests performed for pre-Installation & post-Installation testing and shall be submitted duly signed/certified in hard copy as well as soft copy and copy of files of measurements done with OTDR for each transmission line.**

The tests, checks, adjustments etc conducted by the Bidder prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. During the installation, spliced cable segments shall be tested and documented. Upon completion of a continuous cable path (equipment to equipment locations), all fibres within the cable path shall be demonstrated for acceptance of the cable path Fibre Optic cable site testing minimum requirements are provided in Table 6-7 (a) to 6-7 (c).

Table 6-7(a)
Fibre Optic Cable Pre-Installation Testing
Table 6-7(b)

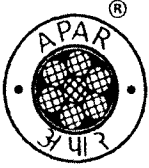
Item:	Description:
1.	Physical Inspection of the cable assembly for damage
2.	Optical fibre continuity and fibre attenuation with OTDR at 1550nm & 1310nm
3.	Fibre optic cable length measurement using OTDR

Fibre Optic Cable Splicing Testing

Item:	Description:
1.	Per splice bi-directional average attenuation with OTDR
2.	Physical inspection of splice box/enclosure for proper fibre routing techniques
3.	Physical inspection of sealing techniques, weatherproofing, etc.

Table 6-7(c)
Fibre Optic Cable Commissioning Testing

Item:	Description:
1.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
2.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter.
3.	Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also)
4.	Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan.



ANNEXURE-B

APAR INDUSTRIES LTD.

REGD. OFFICE & MARKETING OFFICE :
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E : apar.baroda@apar.com
url : www.apar.com

66

AIL/BRD/MKT/ONGC/K-7

September 01, 2016

To,
Mr. Parvinder Singh,
Dy. General Manager (Elect.),
Oil & Natural Gas Corporation Limited,
Cogeneration & Steam System,
Hazira Plant, SURAT- 394 518.

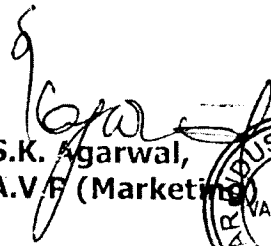
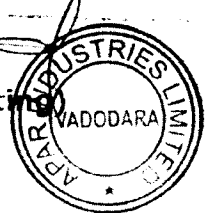
Subject: Tower Related Survey Data Collected with Total Station Device for 66 kV Inchachapore-ONGC Transmission line for Enquiry No. 275E287 for 66 kV GIS ONGC Hazira Plant Re-Conductoring with HTLS Conductor.

Reference- Survey Work Carried out by APAR Industries Ltd. in 66kV ONGC Substation and premises and GETCO 220/66 kV Substation with Total Station device.

Dear Sir,

For the **Enquiry No. 275E287 for 66 kV GIS ONGC Hazira Plant Re-Conductoring with HTLS Conductor**, please find herewith the Report showcasing the Vertical, Horizontal distance for tower type 'P' (Suspension) and 'R' and 'S' type Tension tower along with the distance (span) between the Termination tower and Take off gantry at ONGC Substation, distance (span) between the Termination tower and Tapping gantry at Ichachapore Substation and length of insulator string for Suspension and Tension tower.

Yours faithfully,
For APAR INDUSTRIES LIMITED,


S.K. Agarwal,
A.V.P (Marketing)


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WORKS 2 : CONDUCTOR DIVN. UNIT - III, SURVEY NO. 127.1/2, VILLAGE - ATHOLA, SILVASSA-UMARKUL ROAD, SILVASSA (U.T. OF D & NH) PIN - 396230, INDIA
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CIN : L91110GJ1989PLC012802



ISO 9001 : 2008 CERTIFICATE REGISTRATION NO. 20000164QM08
ISO 14001 : 2004 CERTIFICATE REGISTRATION NO. 20000164UM
OHSAS 18001 : 2007 CERTIFICATE REGISTRATION NO. 20000164BS0H

Page 4/24

TOWER RELATED SURVEY DATA FOR 66 kV ICHACHAPORE-ONGC TRANSMISSION LINE

Tower Related Survey data collection with Total Station Device for 66 kV Ichachapore-ONGC Transmission line:

- For the Enquiry No. 275E287 for Re-Conductoring of existing ACSR Dog Conductor with High Temperature Low Sag (HTLS) conductor for 66 kV Ichachapore-ONGC Transmission line, various Tower Related Data (P=Suspension Tower (0-2°), R (2°-30°) & S (30°-60°)=Tension Tower) as listed below were recorded with the help of Total Station Device:
1. Vertical Distance between the phase of the Double circuit transmission line configuration.
 2. Horizontal Distance between the phase of the Double circuit transmission line configuration.
 3. Existing ground clearance available with the Conventional ACSR Dog Conductor.
 4. Span between Termination Gantry and Take off Tower at 66 kV ONGC Substation.
 5. Span between Termination Gantry and Tapping Tower at 66 kV Ichachapore Substation.
 6. Span between the six (6) numbers of towers each from 66 kV Ichachapore Gantry and 66 kV ONGC Gantry.
- Span between the six (6) numbers of towers from 66 kV ONGC Gantry & Span between Termination Gantry and Take off Tower at 66 kV ONGC Substation.

Data as per Tower Schedule mentioned in Tender (Enquiry-275E287)				Data as per Survey Related Data
Particulars ONGC Compound	Type Gantry	Type Gantry	Span	Span
			75	32.13
206	T	R		
			245	241
205	S	P		
			165	170
204	DT	S		
			65	66
203	DT	S		
			110	113
202	S	P		
			225	213.77
201	S	P		
			180	177.30
200	T	R		



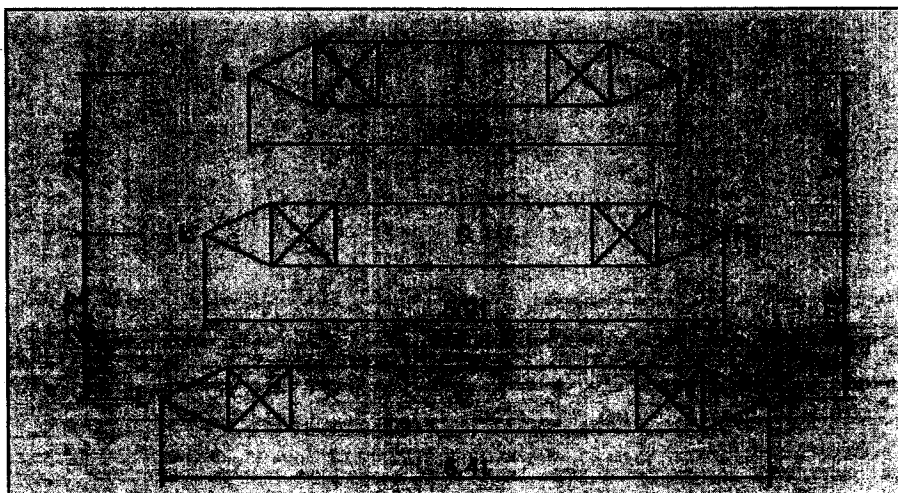
(66)

TOWER RELATED SURVEY DATA FOR 66 kV ICHACHAPORE-ONGC TRANSMISSION LINE

- Span between the six (6) numbers of towers from 66 kV Ichachapore Gantry & Span between Termination Gantry and Tapping Tower at 66 kV Ichachapore Substation.

Data as per Tower Schedule mentioned in Tender (Enquiry-275E287)				Data as per Survey Related Data
Particulars	Type	Type	Span in Mtr.	Span in Mtr.
Ichachapore Compound	Gantry	Gantry		
			100	84.91
1	T	R		
			160	162
2	T	R		
			100	95.09
3	DS	P		
			190	179.83
4	DT	S		
			250	242.56
5	S	P		

- Vertical and Horizontal Distance for 'R' Type Termination Tension Tower towards 66 kV Ichachapore and 66 kV ONGC Substation:



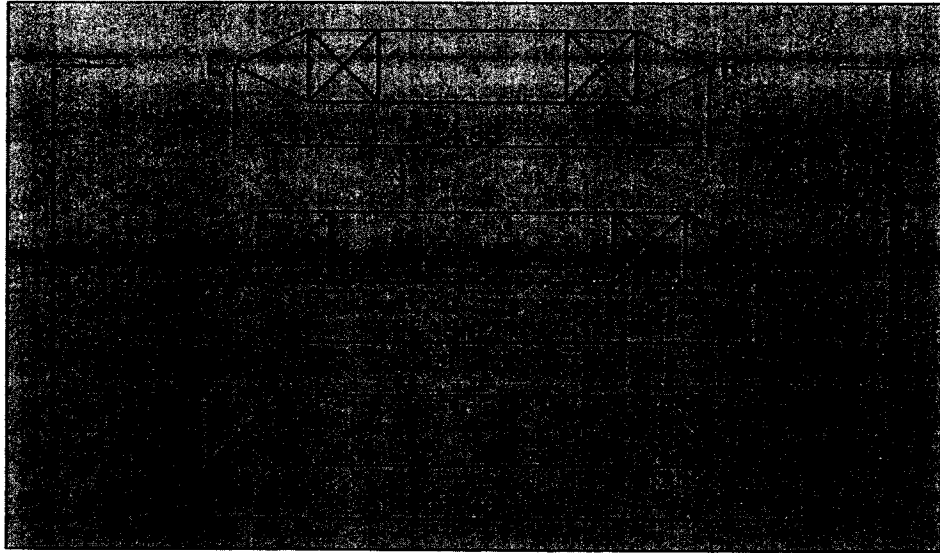
'R' Type Termination Tower



5

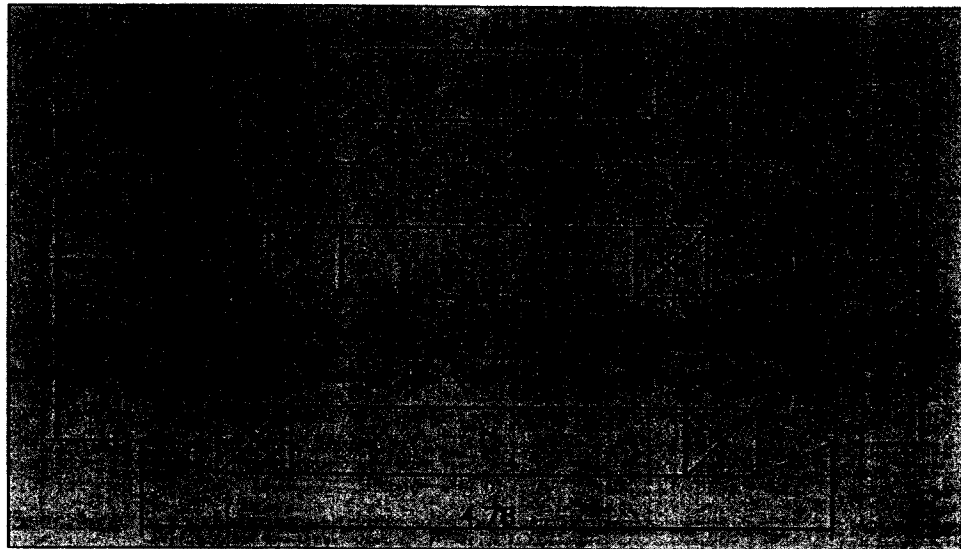
TOWER RELATED SURVEY DATA FOR 66 kV ICHACHAPORE-ONGC TRANSMISSION LINE

- Vertical and Horizontal Distance for 'R' Type Termination Tension Tower intermediate between the Transmission line:



'R' Type Tower

- Vertical and Horizontal Distance for 'P' Type Suspension Tower:

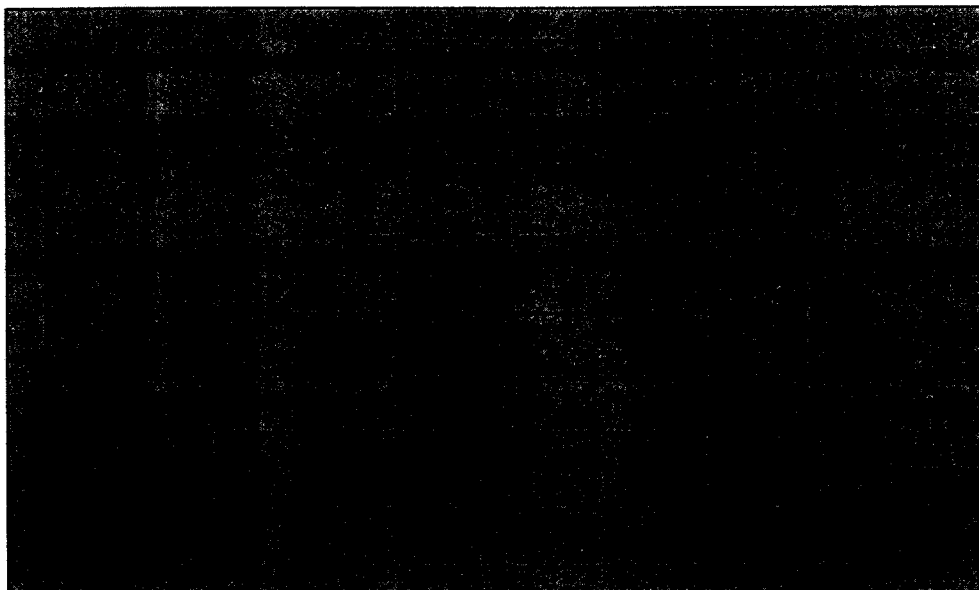


'P' Type Tower



TOWER RELATED SURVEY DATA FOR 66 kV ICHACHAPORE-ONGC TRANSMISSION LINE

- Vertical and Horizontal Distance for 'S' Type Tension Tower:

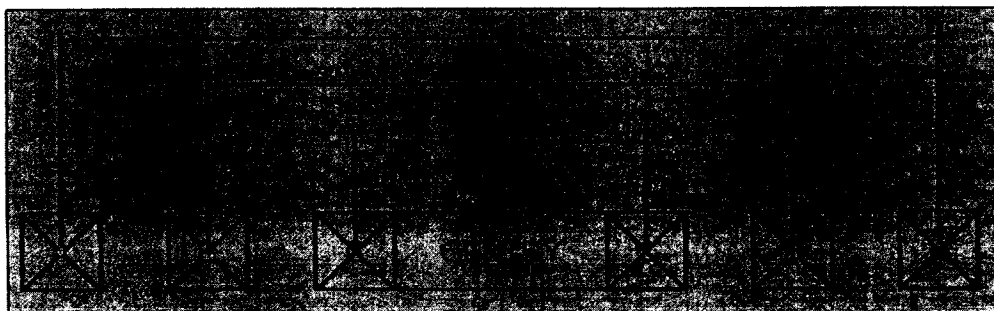


'S' Type Tower

- Horizontal Distance for 66 kV ONGC Take off Gantry:



- Horizontal Distance for 66 kV Ichachapore Tapping Gantry:



63)

TOWER RELATED SURVEY DATA FOR 66 kV ICHACHAPORE-ONGC TRANSMISSION LINE

- Length of Porcelain Disc Insulator for Tension Tower is 0.85 Mtrs.
- Length of Polymer Long Rod Insulator installed on Suspension Tower is 1.09 Mtrs.
- Ground Clearance for the existing ACSR Dog Conductor between the Tower location 206 'R' type and Take off ONGC Gantry in ONGC Premises is 7.15 Mtrs.
- Ground Clearance for the existing ACSR Dog Conductor between the Tower location 205 'P' type and Tower Location 204 'S' type is 7.53 Mtrs.
- Ground Clearance for the existing ACSR Dog Conductor between the Tower location 1 'R' type and Tapping Ichachapore Gantry in GETCO premises is 7.28 Mtrs.



ANNEXURE-B

62

66KV IPORE ONGC line				
LOC NO 1 TO 21				
Lengh- 3905 Km				
Date of comissioning:- 23.11.89				
Conductor used : Dog				
Loc. No.	Type	Type	SPAN In Mtr	Important crossing
Ichhapore Gantry			100	
1	T	R	160	
2	T	R	100	
3	DS	P	190	Sachin Road (6 lane NH 8)
4	DT	S	250	
5	S	P	250	
6	S	P	250	
7	S	P	250	
8	T	R	160	
9	S	P	145	All Tower in ONGC compund
10	T	R	130	
11	T	R	190	
12	S	P	160	
13	S	P	175	
14	S	P	170	
15	T	R	160	
16	S	P	180	
17	S	P	225	
18	DT	S	110	Material Entry gate
19	DT	S	65	
20	S	P	165	Approch road from Mandir(Out of ONGC)
21	T	R	245	ONGC Compound
Ongc Gantry			75	

3905

Total Tension	10
Total Sus.	11
Total	21

SECTION-3

SECTION 3
 PROJECT DETAILS AND GENERAL SPECIFICATIONS

SL.NO.	DESCRIPTION	
1.	PROJECT INFORMATION	
	a) Customer	ONGC Ltd.
	b) Consultant	FICHTNER Consulting Engineers (India) Pvt. Ltd.
	b) Project	66 KV GIS system for 1 X 51 MW CCCPP for ONGC , Hazira
1.0	Location	ONGC Limited, Hazira
2.0	Elevation above mean sea level	RL 6.0 above, MSL
3.0	Nearest Railway Station	Surat, 20 KM
4.0	Nearest Airport	Surat, 10 KM
5.0	Nearest Harbour	Magdalla, 20 KM
6.0	Access Road	NH-8 (30 KM)
7.0	Atmospheric pressure at MSL	1.013 bar
8.0	Ambient Temperature	
a)	Max. average dry bulb temperature	45.6 oC
b)	Min. average dry bulb temperature	4.4 oC
c)	Design temperature for electrical equipment / device	50 oC
9.0	Relative Humidity	
a)	Max.	70%
b)	Min.	18%
c)	Average	64%
10.0	Seismic Zone	III (IS 1893)
11.0	Rainfall	
a)	Max. Intensity of rainfall in 24 hrs.	459.2 mm
b)	Period – Monsoon showers	June to September
c)	Average rainfall per annum	1203.5 mm
12.0	Wind data	
	Max. wind speed (as per IS:875) 20-61 kmph for 20 days in a year < 20 kmph for remaining period	62 kmph
	Most predominant wind direction	South -West
13.0	Land	
14.0	Tropicalisation	
	All equipment supplied against specification shall be given tropical and fungicidal treatment in view of the climatic conditions prevailing at site.	
	Tropical protection shall conform to BS: CP-1014-1965 "Protection of Electrical Power Equipment" against climatic conditions.	

Auxiliary Supply

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415 Volts	± 10%	50 +3% to -5%	3 phase/ 4 wires	Solidly earthed
240 Volts	± 10%	50 +3% to -5%	1 phase/ 2 wires	One point earthed
110 Volts DC	± 10%	DC	1 phase/ 2 wires	Isolated 2 wire system

2. General electrical requirement as per Annexure A (Vol III, Section 3.1 of ONGC specification.(4 pages))

The discharge of pollution in water and air as well as noise levels shall meet with the stipulations of State Pollution Control Board as well as other Acts of the Government under the Ministry of Environment and Forestry. It is a pre-condition that irrespective of what is stated in statutory regulations or any other act or norms, the Specification stipulated environmental qualities standards are the minimum requirements and shall be fulfilled in all aspects.

For control room and offices, noise level shall not exceed 60 dB (A) near to the duct and at other places in the control room/offices noise levels shall not exceed 50 dB (A).

Equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the State/Central government and with the Indian Electricity Rules.

Unless otherwise specified, at least 10 % margin shall be considered in equipment sizing over and above the calculated load current/fault current/power requirements.

If not specified otherwise the electrical operational equipment must be designed to meet protection classes stated below.

- HT Switchgear (Indoor) - IP 4X
- LT Switchgear (Indoor) - IP 52
- Control panels (Indoor) - IP 42
- Relay panel - IP 42
- Motors (indoor) - IP 54
- Motors and other equipment located outdoor - IP 55
- Emergency DG (Indoor) - IP 23

Each individual enclosure accommodating electrical equipment which is liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating

3. Standards and Codes of Practice

All equipment, systems and works covered under these specifications shall be in accordance with all the applicable statutes, regulations, codes and standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Contractor may familiarize themselves with all such requirements.

Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the latest requirements of the Indian Boiler Regulations (IBR), latest Indian Standards /ASME codes,

latest codes and standards as applicable. Any Indian/International standards shall be followed for any imported equipment. For plant layout aspects and area classification requirements OISD standards shall be followed.

The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes as on the date of Award of Contract. A non-exhaustive list of reputed international standards is given below:

- a) American National Standards Institute (ANSI)
- b) American Petroleum Institute (API)
- c) American Society of Mechanical Engineers (ASME)
- d) American Society of Testing and Materials (ASTM)
- e) American Water Works Association (AWWA)
- f) American Welding Society (AWS)
- g) British Standards (BS)
- h) Cooling Technology Institute (CTI)
- i) Deutsches Institut fur Normung (DIN), Germany
- j) Gosstandart of Russia (GOST) standards
- k) Heat Exchange Institute (HEI), USA
- l) Hydraulic Institute Standards (HIS), USA
- m) International Electro-technical Commission (IEC)
- n) Institute of Electrical and Electronics Engineers (IEEE)
- o) International Organisation for Standardisation (ISO)
- p) Japanese Industrial Standards (JIS)
- q) National Electric Code (NEC), USA
- r) National Electrical Manufacturers Association (NEMA), USA
- s) Central Electricity Authority (Construction of Electrical Plants and Electric Lines)
Regulations, Notification, 20th August 2010 and to those referred therein
- t) National Fire Protection Association (NFPA), USA
- u) Occupational Safety and Health Administration (OSHA)
- v) Tubular Exchanger Manufacturers Association (TEMA), USA
- w) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany
- x) OISD

Other international Standards, equivalent or superior to the above Standards can also be adopted. However, In the event of any conflict between the requirements of the international standards or codes and the requirements of the BIS standards or codes, the latter shall govern unless specified

elsewhere in the specifications. Any Indian/International standards shall be followed for imported equipment.

The Plants and Electric Lines (within the plant) shall also be designed to comply with the requirements stipulated in.

- a) Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006.
- b) Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.
- c) Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.
- d) Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.
- e) Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.
- f) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein
- g) Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and
- h) Applicable State Grid Code issued by appropriate Regulatory Commission.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards.

It shall be the responsibility of the Contractor to take all approvals required and get the HRSG registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the Owner/Owner's representative at the time of detailed engineering.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner/Owner's representative and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard and the latest standards shall be followed by the Contractor.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

4. SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid.

Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:

- two sets of special tools and gauges required for the maintenance of the Plant
- one set of special lifting and handling tackles / appliances required for the maintenance of the Plant.

The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Contractor and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.

The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use.

Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.

If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.

Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract. Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.

The Contractor shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The Contractor shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant.

Since the Contract includes site erection, any special tools or appliances required solely for erection shall be provided by the Contractor for his own use and shall remain the property of the Contractor. Control and Instrumentation: Software with associated hardware required to access instruments or control systems to be provided.

5. CLEANING, PROTECTIVE COATING AND PAINTING

Refer Annexure-D (Vol III /Section 2/ Sub Section 2.15 Surface Preparation and Painting.)

6. INSPECTION, TESTING AND INSPECTION CERTIFICATE

Inspection testing shall be done as per customer specification as per Annexure – B.

7. DOCUMENTATION

Format of Documentation

All engineering documents and drawings shall be of international "A" series sizes, that is, A0, A1, A2, A3 and A4.

One set of CD containing all the drawings in Auto CAD (for final as built drawings) shall also be supplied in addition to hard copies.

Soft copy of all other documents shall be supplied in a CD in PDF or editable format. For review purpose pdf or editable version shall be considered.

Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

Numbering and Identification of Documents

All the drawings shall be identified through a common way of numbering in accordance with the requirement of contracting. The numbering system of drawings and documents proposed by the Contractor shall be in compliance with the plant identification system and to be agreed with the Owner/Owner's representative. Apart from this, some drawings may also be numbered in the way which the contractor or subcontractors are used to do. But, there shall be a common title Block on all published drawings which include the following contents:

- Owner
- Owner's Engineer
- Project
- Contractor
- System
- Drawing No.
- Sheet No
- Revision No.

The measuring units and dimensions marked on the project engineering drawings shall be of SI system conforming to ISO 1000.

English words shall be used as descriptions on drawings.

In case dimensions are not marked in conformity with the scale of drawings and any dimension on the drawing does not conform to those dimensions and sizes measured through certain scale, the actual marked dimensions shall be applicable.

For revision of drawings, the revised part shall be clearly and definitely shown on the drawing.

For revision of documents which have been grouped together, a brief description shall be a perpendicular line with the margin of the revised copy closely following it.

Provision for Documents

Generally, copies of drawings or documents containing trade secret and drawings with patented nature need not be provided.

However, to know whether the Contractor has performed its obligations, the Owner/Owner's representative has the right to examine those drawings within the Contractor's working scope. The Contractor shall meet the Owner/Owner's representative's reasonable demands to files and do the following to satisfy the Owner/Owner's representative:

- Contractor will work according to the requirements specified in the contract.
- Contractor's working has been arranged properly and developed according to the plan.
- The quality control system is reliable.
- After receiving all documents necessary for power plant operation and maintenance, Contractor shall supply equipment and systems.
- Having received all necessary documents for Contractor to perform its legal obligations or other relevant responsibilities.

Distribution of documents

The source, distribution, no. of copies shall be as per the following document distribution schedule. Annexure –C.

Title block for the Project:

a) Customer	ONGC
b) Consultant:	FICHTNER Consulting Engineers (India) Pvt. Ltd.
c) Project:	66 KV GIS system for 1 X 51 MW CCCPP for ONGC , Hazira
d) Main Contractor	BHEL

DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings in 2D and 3D format.
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

DOCUMENTATION SCHEDULE AT CONTRACT STAGE

No. of Copies	A: For Approval
5	Copies of GA drawings (2d and 3D) with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
5	Copies of type test reports
5	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.
5	Copies of manufacturing and field quality plan.

5	Copies of installation, operation & Maintenance manual.
	B : After Approval and For Information/Distribution.
12	Copies of All drawings
12	Bound sets containing all drawings/manuals, type and routine test reports etc. along with sub-vendor's test reports for all bought out assemblies/components/parts including Internal wiring diagrams and exploded diagrams of assemblies/ parts, shall be furnished.
12	Copies of Installation, Operation & Maintenance manual.
	C: On Completion of Entire works
12	Bound sets of Installation, Operation & Maintenance manual and all as built drawings
12	Set of Computer CD-ROMs (with unbreakable CD Covers) containing all as-built drawings in Auto-Cad version 2008 or later with 2D and 3D drawings, Instruction Manual and GTP.

8. Package, storage

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them.
Three classes for storehouse are described as follows:

Storehouse class A items: Special measures are taken to protect the stored goods and the temperature, humidity are controlled within a specified range.

Storehouse class B items: Goods are stored with temperature uncontrolled.

Storehouse class C items: It is an outdoor storage with a drainage system on the ground.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground, should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible

Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oilcloth or wax or other similar materials between the machine surface and ground surface.

All components shall be inspected for their painting, storing, sealing and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage in an interval of every 4 weeks.

(53)

9. SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid.

Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

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The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use.

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Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract. Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.

The Contractor shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The Contractor shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves.

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant.

Since the Contract includes site erection, any special tools or appliances required solely for erection shall be provided by the Contractor for his own use and shall remain the property of the Contractor.

Control and Instrumentation: Software with associated hardware required to access instruments or control systems to be provided.

10. Painting, Insulation, Anti-dewing

Anti-corrosive coatings and painting shall be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have distinct colours so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Colour strip indication system should be used for pipes. These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some colour in whole length.

The principal colour of field equipment should be determined by Owner/Owner's representative and Contractor during execution stage. For Electrical equipment, paint shade shall be as mentioned in the equipment Specification.

Further requirements with regard to painting, insulation, and anti-dewing are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the Contract.

Insulation specification for MPP supplied equipment shall be as mentioned in detailed technical specification.

Language to be used

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale shall be marked in English.

Documents for training shall be provided in English.

Danger signs / Exit signs shall be in English, Hindi and Gujarati.

11. CONSUMABLES

12.1.0 Lubricants and greases

All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site.

All oils and greases shall where possible be readily available in India.

The number of oils and greases shall be kept to a minimum to the extent feasible. For each type and grade of lubricant recommended the contractor shall list at least three equivalent lubricants manufactured by alternative companies. This will be in line with that suggested by OEM and outcome will be informed to the Owner/Owner's representative.

In case of imported oils, lubricants and other consumables, the contractor shall indicate the indigenous equivalents to enable the Owner/Owner's representative to arrange subsequent fills. Preference should be given to indigenous oils and lubricants during first filling itself. Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.

The Contractor shall supply the first fill lubricants and greases, and also shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

12.2.0 Chemicals and other consumables

Contract includes the supply (by the Contractor) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works. The Contractor shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

The Contractor shall deliver to site sufficient quantities of consumables in his supply to allow for 6 months running of the Works prior to the issue of the Completion Certificate. The delivery of the remainder of the consumables shall be programmed to suit the operational requirements and space availability within the various stores.

12. Plant and Equipment Identification

The contractor shall follow identification system for the whole plant equipment, instruments, facilities and systems as per the Annexure-4 Guide for Coding Equipment, Documents & Drawings MPP generated drawings, identification system shall be based on MPP standard.

Labelling

Name plates which are to be firmly fixed on all the equipment, instruments, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the piping or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them. Indoor installed equipment (e.g., panels, cabinets, switchgear) shall also be labelled by appropriate name plate.

The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Contractor and the Owner/Owner's representative. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags. All buried pipes and cables routes shall be identified with permanent marker.

FICHTNER Consulting Engineers (India) Private Limited.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.1
			Sheet No.
			370

VOLUME - III

SUB-SECTION - 3.1

GENERAL ELECTRICAL REQUIREMENT

1.0.0 INTENT OF SPECIFICATION

- 1.1.0 This specification covers the design, manufacture, assembly, testing at manufacturer's works, packing, transportation to site including transit insurance, unloading, erection, testing & commissioning of Electrical Equipment complete with all accessories for efficient and trouble-free operation of combined cycle captive power project.
- 1.2.0 It is not the intent to specify completely herein all details of the equipment; nevertheless, the equipment shall be complete and operative in all respects and shall conform to the highest standard of engineering, design and workmanship.

2.0.0 ELECTRICAL SYSTEM DESCRIPTION

- 2.1.0 The proposed Power plant consisting of one Gas Turbine Generator (GTG) & one Steam Turbine Generator (STG). GTG shall be connected to the new 66kV indoor type Gas Insulated Switchgear (GIS) through a Step-up Generator Transformer using phase segregated bus duct. STG shall be connected to the 66kV Outdoor type Gas insulated switchgear (GIS) through a Step-up Generator Transformer using phase segregated bus duct. Power shall be evacuated from 66kV GIS to the grid through the 66kV outgoing line feeders. For commissioning of plant the start-up power shall be drawn from grid to the 66kV GIS.
- 2.2.0 Auxiliary Power supply is envisaged at 11kV & 415V level. Two numbers of Station Transformers are provided for supplying unit loads.
- 2.3.0 Required numbers of unit and station service transformer (11/0.415 kV) are provided for supplying 415V loads. Electrical Auxiliary power distribution arrangement & Power Evacuation Arrangement is shown in the enclosed "Key Single Line diagram" (Drg. No. 00-5111168-E-201, 2 sheets).
- 2.4.0 One number Black start cum Emergency DG set shall be considered for starting of Gas turbine and safe shutdown of units. During blackout condition Diesel Generator (DG) set shall feed essential loads, same Diesel generator set shall feed unit emergency loads for safe shut down of Units.
- 2.5.0 To provide uninterrupted power supply to DCS and other Control Panels, a dedicated 110 V AC UPS system shall be provided. To feed essential loads, such as the emergency oil pumps, Control. Supply to Switchgears / Panels, Emergency DC lighting etc, 110 V DC supply backed by DC Batteries shall be provided. DC system shall include 66kV GIS control supply requirements also.
- 2.6.0 If 125V DC system is required by the Gas Turbine supplier as per manufacturer's standard the same shall also be provided.
- 2.7.0 Plant communication system shall be provided with Public address system & telephone system.
- 2.8.0 For all electrical MV/LV/Control panels, Local control panels and Junction boxes, Transformers, etc shall be painted with RAL 7032.

FORM TSP REV-A (MUM)

FICHTNER Consulting Engineers (India) Private Limited.

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.1
			Sheet No.
			371

3.0.0 ELECTRICAL SYSTEM DESIGN

- 3.1.0 The plant shall be designed to operate in islanding mode of operation on tripping of all the grid incoming lines and Steam Turbine generator, so that the Gas Turbine generator unit can be made running with the available plant load under such condition.
- 3.2.0 The design, manufacture, assembly, shop testing, erection, testing & commissioning as well as performance of the equipment shall conform to the latest edition of relevant IS / IEC specifications.
- 3.3.0 Before starting manufacture of any equipment the Contractor shall have to take approval of relevant drawings and data from the Owner/Owner's representative.
- 3.4.0 All equipment supplied and all work carried out including design and detailed engineering shall comply with the statutory requirements local Government as well as Central Government and with the Indian Electricity Rules. The accuracy class of meters, CTs, PTs (inside GIS) for energy accountability shall be as per latest GETCO regulations.
- 3.5.0 Unless otherwise specified in the respective section, Electrical design ambient for all equipment sizing shall be considered as 50 Deg C dry bulb temperature and 95% RH. All the equipment are required to operate in a highly corrosive environment and highly humid (at coastal area) atmosphere.
- 3.6.0 Unless otherwise specified, at least 20 % margin shall be considered in equipment sizing over and above the calculated load current/fault current/power requirements.
- 3.7.0 Makes of all Electrical equipment are subject to prior approval by the purchaser. Similar equipment and components shall be of same make. Equipment of same type and rating shall be interchangeable.
- 3.8.0 The 415V PCC & MCC panels shall be of minimum FORM 3B type of construction.
- 3.9.0 In respect to the above LV circuit breaker selection, following should be considered as per IEC:-

Utilisation Category	Application
Category A	Circuit-breakers with no assigned short-time rating (e.g Current limiting ACBs and MCCBs) cannot be used if coordination is required with downstream switchboard feeders. Applicable for the outgoing feeders
Category B	Circuit-breakers with assigned short-time rating (e.g ACBs and some Supplier's larger rated MCCBs) that shall be used if coordination is required with downstream switchboard / MCCs. Applicable for the incomer and outgoing feeders.

Outgoing feeders not requiring any coordination for example motor feeders Category "A" MCCB can be considered.

- 3.10.0 In switchgear for Motor feeders rated 15kW & above an ammeter & transducer shall be provided. All transducers will be of dual output type.
- 3.11.0 All LT motors rated 90 kW & above shall be controlled through Air Circuit Breakers. LT motors rated below 90 kW shall be controlled by fused contactor. In addition to the above ELCB shall be provided for all 415V motor feeder. Each feeder shall also provided with O/L relay and SPPR relay.
- 3.12.0 For the motor feeders, the essential auxiliaries shall have contactors with delayed drop out feature adjustable up to 3 sec and necessary auto reset facility and the relay should be of digital type. The

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.1
			Sheet No.
			372

list of motors shall not be limited to BFP, AOP, JOP, lube oil pump, compressors, barring gear and any other drive recommended by GTG,STG & HRSG vendor.

3.13.0 The power cables upto and including 10 sq.mm should be copper conductor and above 10 sq.mm Aluminium conductor may be used. For CT circuits minimum cable size shall be 4sq.mm copper. Minimum size of control cables shall be 2.5sqmm. 20% spare cores shall be provided in all control cables. The maximum no. of cores shall be limited to 27.

3.14.0 The equipment supplied shall meet the requirement of state electricity and Indian grid code.

3.15.0 The Substation Automation System (SAS) shall have provision for interfacing with remote PLDC (Regional Load Dispatch Centre) through suitable gateways with adequate number of ports along with modems at substation level.

3.16.0 Voltage Levels shall be as follows:

- Power Evacuation : 66 kV (+10%), 3 phase, 3 wire 50 Hz, effectively earthed.
- Generation Voltage : Manufacturer's standard Voltage, 3 phase, 50 Hz
- Plant HT Auxiliary Supply : 11000V (+10%), 3-phase, 3W, 50 Hz, earthed through resistance.
- Plant LT Auxiliary Supply : 415V (+10%), 3 phase, 4 wire, solidly earthed.
- Plant LT Emergency Supply : 415V (+10%), 3 phase, 4 wire ungrounded.
- Plant DC Supply : 110V (+10% to -15%), DC 2 wire unearthed.
- Plant UPS Supply : 110V (+10%), 1 phase, 2 wires 50 Hz, A.C.
- Transducers : 110V DC (For LT boards 230V AC)
- Metering : 110V AC PT Voltage
- Control & protection : 110V, DC 2 wire unearthed
- Panel lighting and space heaters : 240V, 1-phase, 2wires 50 Hz, A.C. with one point earthed.
- Control Supply for Breaker feeders : 110V, DC 2 wire unearthed
- Control Supply for LV DOL modules : 110V, 1 phase, 2 wires
- Permissible Frequency variation for generator : +3% to - 5%
- Permissible Frequency variation for auxiliaries : +5% to - 5%
- Voltage level for AC Motors below 0.2 kW : 240 V, Single phase, 50 Hz, with DOL start.
- Voltage level for AC Motors from 0.2kW up to and including 160 kW : 415 V, 3 phase, 50 Hz, with DOL start.
- Voltage level for A.C Motors above 160 kW : 11000V, 3 phase, 50 Hz, with DOL start.

3.17.0 Design short circuit levels shall be at least the following and has to be supported by calculation:

- Three phase symmetrical short circuit ratings of 66kV System : 40 kA for 3 sec
- Three phase symmetrical short circuit ratings of 11kV System : 44 kA for 3 sec
- Earth fault current for 11kV System : 100A.
- Three phase symmetrical short circuit ratings of 415V System : 50 kA for 1sec
- Short circuit ratings of 110V DC System : 20 kA for 1 sec (min)

3.18.0 Insulation level at various voltages shall be as follows:

66kV System

- One minute Power Frequency withstand voltage : 140 kV (rms)
- Switching Impulse withstand Voltage : 325 kV (peak)

Subject	Doc. No.	Rev.	Vol. / Sec.
BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 3.1
			Sheet No.
			373

11kV System

One minute Power Frequency withstand voltage : 28 kV (rms)
1.2/50 Micro sec, impulse withstand voltage : 75 kV (peak)

415 V System

One minute Power Frequency withstand voltage : 3 kV (rms)

3.19.0 Sizing criteria for auxiliary transformers

Design Criteria for Auxiliary Transformer and Generator Transformer

i. The Contractor shall size the auxiliary transformer as per sizing criteria furnished below:

Min. Rating of each Auxiliary transformer (in kVA at p.f.0.8) = $1.2 \times (\text{Sum of total connected load} + \text{Max of (sum of 20\% of total standby loads or the largest standby load) + max of (sum of 50\% total intermittent loads or the largest intermittent load)})$

✓ The auxiliary transformers shall be sized for 2x100%

4.0.0 QUALITY ASSURANCE, TESTING & INSPECTION

4.1.0 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, tested, and commissioned at all the stages, as per approved Quality Plan.

4.2.0 All tests shall be conducted as per relevant IS/IEC/IEEE standards and shall be performed in the presence of purchaser's representative, if so desired by the purchaser. The Bidder shall give at least 15 days advance notice of the date when the tests are to be carried out.

4.3.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Type testing shall be conducted without any cost implication to the purchaser if type testing is not already carried out for any equipment supplied. For the various bought out items test certificates from equipment manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards whether specifically mentioned or not. Specific type tests are to be carried out as specified in individual equipment specifications.

4.4.0 Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Purchaser's written approval of the test reports.

The charges for carrying out all routine tests shall be deemed to be included in the Bid price. The charge of carrying out each type test/ special test if any shall be given separately in "Unit Price Schedule".

FICHTNER Consulting Engineers (India) Private Limited.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	II / 1
				Sheet No. 51

7.17.0 List of Approved Sub-vendors

Refer Volume IV/Annexure-1/ Section 8.

With full information substantiating the technical acceptability of the proposed change. The Owner/Owner's representative's decision shall be final. Concessions granted shall not absolve the Contractor from any of his responsibilities under the Contract.

8.0.0 QUALITY ASSURANCE, SHOP INSPECTION AND TESTING**8.1.0 General**

This section contains general requirements for inspection of material, parts, equipment and workmanship of the plant during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability of plant operation and performance.

The Owner/Owner's representative and/or authorised Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the plant items available for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner/Owner's representative, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner/Owner's representative shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

8.2.0 Scope

All materials, components and equipments covered under this specification shall be tested at all stages of procurement, manufacturing, erection, commissioning as per a comprehensive quality assurance programme. The requirements of minimum quality plans to be followed by the Bidder in respect of various equipment are specified in detailed technical specification. The Bidder shall draw his own quality plans in line with these requirements and his standard practices and implement such programme after approval by the Owner/Owner's representative. The Owner/Owner's representative shall appoint a Third party inspection (TPI) agency for bought out items/outside inspection. The Owner/Owner's representative will carry out on-site supervision and inspection.

Manufacturing quality plan shall detail out, for all the components and equipments, various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by contractor's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised during all stages of material procurement, manufacture, assembly and final testing/performance testing.

The Contractor has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organization and that the Contractor monitors the performance of these by the attendance at tests of experienced inspectors employed by the Contractor. The Contractor shall, at the appropriate time, prove that his

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	II / 1
				Sheet No.
				52

material and / or equipment comply with all the requirements of this Section, such proof being the successful completion of tests and inspections. Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.

All materials, components and equipment supplied under the contract shall be subject to inspection by the Owner/Owner's representative, his representative, Inspectors of Boilers (India) or his authorized Agency or any other Inspector of the Government, should they so require during manufacture, erection and after completion. The necessary inspection charges of the authorized agency of Inspection of Boilers (India) shall be borne by the contractor. The inspection and tests shall include but shall not be limited to the requirements of this section of the specification. Further requirements to be applied are specified in the detailed specification.

The Bidder along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure referred by him in quality plans. These quality plans and reference documents/standards will be subject to Owner/ Owner's representative's approval and will form a part of the contract. In these approved quality plans, Owner/Owner's representative shall identify customer hold points (CHP), indicating tests/checks which shall be carried out in presence of the Owner/Owner's representative's or authorized representative and beyond which work will not proceed without consent of Owner/Owner's representative's in writing.

No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Owner/Owner's representative or such pre-dispatch final inspection is waived by the Owner/Owner's representative and dispatch is authorized after review of test reports.

All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports duly approved by the Owner/Owner's representative. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.

All material used for equipment construction including castings and forgings shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or as specified in detailed specification.

All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner/Owner's representative for approval prior to carrying out qualification test in the presence of I/Owner/Owner's representative

All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.

Test results of qualification tests and specimen testing shall be furnished to the Owner /Owner's representative for approval. However, wherever required by the Owner/ Owner's representative, tests shall be conducted in presence of Owner/Owner's representative

All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	II / 1
				Sheet No. 53

All the sub-vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment-(list of which shall be drawn up by the Bidder along with his offer and finalized with the Owner/Owner's representative) shall be subject to Owner/ Owner's representative's approval.

The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the Owner/Owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.

8.3.0 Inspection Program and Test Notifications

Before manufacturing commences and not later than 45 days after award of contract, the Contractor shall submit an outline of his proposed inspection program, which shall include all major stages during manufacturing. The inspection and test program shall include for the various items the designation No., name of equipment, part of equipment, the kind of test, test standard, company which carries out the test, place, date and witnesses by the Contractor, third party or Owner/Owner's representative's .

The Owner/Owner's representative will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by Fax or email in a format to be agreed and shall be sent at least 20 days prior to the intended test in accordance with 'Conditions of Contract'. If the Owner/Owner's representative intends to be represented at the test he will provide at least 24 hours' notice and if his representative does not attend on the notified date, the test may proceed unless an alternative date has been requested by the Owner/Owner's representative.

8.4.0 Test Certificate Documentation

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

Three copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner/Owner's representative prior to commissioning.

Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

8.5.0 Certification of Equipment by Owner/Owner's representative's

The Personal and travelling costs in connection with the Owner/Owner's representative's inspection and witnessing of tests of equipment, components and material manufactured in India and abroad will be borne by the Owner/Owner's representative.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	II / 1
				Sheet No.
				54

8.6.0 Codes and Standards

8.6.1 General

The type and extent of inspection shall generally be in accordance with that specified in the standard used for design and construction of the item of equipment supplemented or amended by the requirements of this section of the specification. The Contractor should provide the relevant codes and standard to the Owner/Owner's representative.

8.6.2 Reference to Codes and Standards

Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equalled or exceeded in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner/Owner's representative.

In all instances, the finally accepted applicable code or standard shall be the version last published.

8.6.3 Alternative Standards

Where no appropriate standard is available, tests shall be conducted in accordance with the manufacturer's standard practice, subject to the approval of the Owner/Owner's representative.

In such cases the Contractor shall submit to the Owner/Owner's representative, complete data and a suggested procedure for the testing to be performed. Commencement of manufacture before receipt of the Owner/Owner's representative's approval shall be at the Contractor's risk.

If the proposed procedures are accepted, the Contractor shall provide the Owner/Owner's representative with four additional copies in English before any test is performed.

8.6.4 Derating Standards

The Contractor's attention is drawn to the climatic conditions in the site area. Derating factors shall apply in accordance with the relevant and approved standards if not specified in the contract documents.

8.7.0 Services prior to and During Inspection and Testing

In accordance with and in addition to specified standards the Contractor shall submit procedures for material testing, manufacture, quality control and performance testing as they apply from the procurement phase of raw materials to the finished product. Manufacture commenced before receipt of the Owner/Owner's representative's approval of material specifications and testing procedures shall be at the Contractor's risk.

No inspection shall be valid unless the Contractor and manufacturer are in possession of relevant approved drawings and procedures for the item to be tested. The Contractor on

FICHTNER Consulting Engineers (India) Private Limited.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	II / 1
				Sheet No.
				84

16.4.1 Document Distribution Schedule - After Placement of Order

Sl. No.	Document	Total Copies	Distribution		
			Owner		Owner's representative
			HQ	SITE	
1.	PERT Network, work schedules, Bar charts, Layout drawings	10	-	5	5
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	10	-	5	5
	- Revised	10	-	5	5
3.	Approved drawings and documents.	10	-	5	5
4.	Instruction manuals for erection and O&M	10	-	8	2
5.	As built drawings including O & M manual				
	- Hard Copy	10	-	8	2
	- Soft Copy	-	-	-	-

FICHTNER Consulting Engineers (India) Private Limited.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				330

SUB-SECTION - 2.15

SURFACE PREPARATION AND PAINTING

CONTENTS

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.0.0	SURFACE PREPARATION	331
2.0.0	SCHEDULE OF PRIMER & FINISH COATS	337
3.0.0	PAINT SYSTEM	342

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				331

SUB-SECTION – 2.15

SURFACE PREPARATION AND PAINTING

1.0.0 SURFACE PREPARATION

1.1.0 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, component and system. The components and/or equipment shall be mechanically and / or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop.
- Cleaning before painting and / or corrosion protection (application of prime coat).
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment of welding at manufacturer's work or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method of for works cleaning except where this is precluded by design or access considerations.

Mechanical surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted wire brushless used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic / plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

The contractor shall arrange at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following.

- Proper storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- Application of paints and the recommended limit on the intervals between coats.
- Shelf life for storage.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				332

Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation of painting work in any specific location, even prior to completion of system test.

1.2.0 Tools & Tackles

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment and air compressor etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange to his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operation in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

1.3.0 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Purchaser is prepared to consider alternative methods provided they achieve the necessary surface condition.

1.3.1 Surface condition

The Metal surfaces shall be clean and free of mill scale, rust dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

1.3.2 Abrasives

Abrasives containing silica, silicates of slag, residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

1.3.3 Removal of abrasive and debris:

After cleaning abrasive and debris shall be thoroughly removed from components.

1.3.4 Alternative Chemical Cleaning at Manufacturer's Works

The procedure shall comprise of Pre-treatment and Acid treatment.

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				333

1.3.5 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

1.4.0 Weather Conditions

Painting shall be done only when the surface temperature is above 5°C surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc. before drying, shall be permitted to dry & the damaged area of primer shall be removed and the surface prepared & primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

1.5.0 Surface Preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired so as to obtain a clean, dry, even surface to receive the priming or finishing coat(s) as called for in the painting schedules. Sharp edges should be rounded especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surface should be blast cleaned whenever possible.

1.5.1 Surface preparation methods.

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 5900 or Steel Structures Painting Council, SSPC, Vis1, or DIN 55928, section 4.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				334

1.5.1.1 White metal blast cleaning: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal, Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour & correspond in appearance to the prints designated Sa 3.

1.5.1.2 Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated Sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

1.5.1.3 Commercial Blast Cleaning Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasting is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint system.

1.5.1.4 Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

1.5.1.5 Very thorough mechanical scraping and wire brushing St 3

St 3 very thorough scraping and wire-brushing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for St 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

1.5.1.6 Thorough scraping and wire brushing: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				335

Table -1 (Surface Preparation Standards)

Surface preparation methods	SIS 055900	DIN 55928, Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting ACC to item (a)	Sa 3		First quality	White metal SP 5
Blasting ACC to item (b)	Sa 2 1/2		Second near quality	White SP 10
Blasting ACC to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand / or power tool derusting ACC to item (f)	St 2		--	Hand tool cleaning SP 2
ACC to items (e)	St 3		--	Power tool cleaning SP 3
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar (g) at the nozzle shall be used.

After blast-cleaning all accumulated grit, sand, dust etc. must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				336

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

1.5.2 Rub Down and Touch up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirits is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

1.5.3 Non Compatible Shop Primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be spot cleaned in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units / equipment, shop primer shall be as per the paint system given for particular environment.

In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual / mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled off before application of the coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

(34)

FICHTNER Consulting Engineers (India) Private Limited.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No. 337

2.0.0 SCHEDULE OF PRIMER & FINISH COATS

2.1.0 PRIMERS

- P-1 Red Oxide zinc chromate primer
- P-2 High build chlorinated rubber zinc phosphate primer
- P-3 High build zinc phosphate primer
- P-4 Etch primer/wash primer
- P-5 Epoxy zinc chromate primer
- P-6 Epoxy zinc phosphate primer
- P-7 Epoxy high build mio paint
- P-8 Epoxy red oxide zinc phosphate primer
- P-9 Epoxy based tie coat finish coats
- P-10 Inorganic zinc silicate coating.

2.2.0 FINISH COATS

- F-1 Synthetic enamel
- F-2 Acrylic polyurethane paint
- F-3 Chlorinated rubber paint
- F-4 High build chlorinated rubber mio paint
- F-5 Chemical resistant phenolic based enamel
- F-6 Epoxy high build coating
- F-7 High build coal tar epoxy
- F-8 Self priming epoxy high build coating
- F-9 High build black
- F-10 Heat resistant aluminium paint suitable upto 250°C
- F-11 Heat resistant silicone paint suitable upto 400°C
- F-12 Synthetic rubber based aluminium paint suitable upto 150°C
- F-13 Heat resistant silicone paint suitable upto 600°C

2.3.0 PRIMER

a) Primer (P-1) Red oxide zinc chromate primer

- Type and composition : Single pack modified phenolic alkyd medium pigmented with red oxide and zinc chromate
- Volume solids : 30 - 35%
- DFT : 20 ~ 40 microns/coat (min)
- Covering capacity : 11-13 sq. m/Lit/coat

b) Primer (P-2) High build chlorinated rubber zinc phosphate primer

- Type and composition : Single pack Chlorinated rubber medium plasticised with unsaponifiable plasticiser pigmented with zinc phosphate
- Volume solids : 35-40%

FORMT9-P REV-B (MUM)

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				338

DFT : 50 microns/coat (min).
Covering capacity : 7-8 sq. m/lit/coat

c) Primer (P-3) High build zinc phosphate primer

Type and composition : Single pack Synthetic medium, pigmented with zinc phosphate
Volume solids : 40 - 45%
DFT : 35 - 50 microns/coat
Covering capacity : 10 - 12 sq. m/lit/coat
Heat resistant : Upto 100 °C (dry)

d) Primer (P-4) Etch primer / Wash primer

Type and composition : Two pack of Polyvinyl butyl resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate
Volume solids : 7 - 8%
DFT : 8 - 10 microns/coat
Covering capacity : 7 - 8 sq. m/lit/coat

e) Primer (P-5) Epoxy zinc chromate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with zinc chromate
Volume solids : 40% (min.)
DFT : 35 microns/coat
Covering capacity : 11 - 12 sq. m/lit/coat

f) Primer (P-6) Epoxy zinc phosphate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with zinc phosphate
Volume solids : 40% (min)
DFT : 35 microns/coat (min)
Covering capacity : 11 - 12 sq. m/lit/coat

g) Primer (P-7) Epoxy high build MIO paint (Intermediate coat)

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with micaceous iron oxide
Volume solids : 50% (min)
DFT : 100 microns/coat (min)
Covering capacity : 5.0 sq. m/lit/coat

h) Primer (P-8) Epoxy red oxide zinc phosphate primer

Type and composition : Two pack of Polyamide cured epoxy resin medium pigmented with red oxide and zinc phosphate
Volume solids : 42% (min)
DFT : 30 microns/coat (min)
Covering capacity : 13 - 14 sq. m/lit/coat



FICHTNER Consulting Engineers (India) Private Limited.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				339

i) Primer (P-9) Epoxy based tie coat

(Suitable for conventional alkyd based coating prior to application of acrylic polyurethane / epoxy finishing coat).

Type and composition	:	Two pack of Polyamide cured epoxy resin medium suitably pigmented
Volume solids	:	45-60%
DFT	:	40 microns/coat (min)
Covering capacity	:	10 - 12 sq. m./lit/coat

j) Primer (P-10) Inorganic Zinc silicate coating

Type and composition	:	Two pack of Self cured Ethyl - silicate solvent based Inorganic Zinc coating.
Volume solids	:	60% (min)
DFT	:	65-75 microns/coat
Covering capacity	:	8-9 sq.m./lit/coat

2.4.0

FINISH COATS

a) Finish coat (F-1) Synthetic Enamel

Type and composition	:	Single pack Alkyl medium pigmented with superior quality water & weather resistant pigments
Volume solids	:	30 - 40%
DFT	:	20 - 25 microns/coat (min)
Covering capacity	:	16 - 18 sq. m./lit/coat

b) Finish coat (F-2) Acrylic Polyurethane paint

Type and composition	:	Two pack Acrylic resin and isocyanate hardener suitably pigmented.
Volume solids	:	40 % (min)
DFT	:	30-40 microns/coat
Covering capacity	:	10-12 sq.m./lit/coat

c) Finish Coat (F-3) Chlorinated Rubber paint

Type and composition	:	Single pack Plasticised chlorinated rubber medium with chemical & weather resistant pigments.
Volume solids	:	30 % (min)
DFT	:	30 microns/coat (min)
Covering capacity	:	10 sq.m./lit/coat

FORM T9-P REV-B (MUM)

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				340

d) Finish Coat (F-4) High build chlorinated rubber MIO paint.

Type and composition	:	Single pack Chlorinated rubber based high build pigmented with micaceous iron oxide.
Volume solids	:	40-50 %
DFT	:	65-75 microns/coat
Covering capacity	:	6-7 sq.m./lit/coat

e) Finish Coat (F-5) Chemical Resistant Phenolic based Enamel

Type and composition	:	Single pack Phenolic medium suitably pigmented.
Volume solids	:	30-40%
DFT	:	25 microns/coat (min)
Covering capacity	:	15 sq.m./lit/coat

f) Finish Coat (F-6) Epoxy High Building Coating

Type and composition	:	Two pack Polyamide cured epoxy resin medium suitably pigmented.
Volume solids	:	55-65%
DFT	:	100 microns/coat (min)
Covering capacity	:	6.0-6.5 sq.m./lit/coat

g) Finish Coat (F-7) High build coal tar Epoxy.

Type and composition	:	Two pack Polyamine cured epoxy resin blended with coal tar.
Volume solids	:	65 % (min)
DFT	:	80-125 microns/coat
Covering capacity	:	6.0-6.5 sq.m./lit/coat

h) Finish Coat (F-8) Self priming epoxy high build coating (complete rust control coating)

Type and composition	:	Two pack Polyamido-amine cured epoxy resin suitably pigmented. Capable of adhering to manual prepared surface and old coatings.
Volume solids	:	65-85%
DFT	:	100-125 microns/coat
Covering capacity	:	4-5 sq.m./lit/coat

i) Finish Coat (F-9) High build black.

Type and composition	:	Single pack Reinforced Bituminous composition phenolic based resin.
Volume solids	:	55 - 66 % (min)
DFT	:	100 microns/coat (min)
Covering capacity	:	5.5 - 6.0 sq.m./lit/coat

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No. 341

j) Finish Coat (F-10) Heat Resistant Aluminium Paint Suitable upto 250°C

Type and composition	:	Dual container (paste & medium) Heat resistant special Ole Ore resinous medium with leafing aluminium.
Volume solids	:	20 - 25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	10 - 12 sq.m./lit/coat

k) Finish Coat (F-11) Heat Resistant Silicon paint suitable 250 - 400°C.

Type and composition	:	Single pack of Silicon resin based with aluminium flakes
Volume solids	:	15-25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	7-12 sq.m./lit/coat

l) Finish Coat (F-12) Synthetic Rubber Based Aluminium Paint suitable upto 150°C.

Type and composition	:	Single pack of Synthetic rubber medium combined with leafing Aluminium.
DFT	:	20-25 microns/coat (min)
Covering capacity	:	9.5 sq.m./lit/coat

m) Finish Coat (F-13) Heat Resistant Silicon paint suitable 500 - 600°C

Type and composition	:	Single pack of Silicon resin based with aluminium flakes.
Volume solids	:	25-35%
DFT	:	20 - 25 microns/coat (min)
Covering capacity	:	12 - 14 sq.m./lit/coat

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				342

3.0.0 PAINT SYSTEM

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
1	Structural steel work, piping (oil + water) tanks outside surface, transmission towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Intermediate Finish	1	P7	35	x	
					1	F2	100		x
						Total DFT	50		x
							220		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20		x
							20		x
						Total DFT	135		
3	Structural steelwork, piping, un-insulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	
				Intermediate	1	F12	20		x
				Finish	1	F12	20		x
						Total DFT	115		
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Finish			35	x	
					1	F6	100		x
						Total DFT	170		

(29)

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				343

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
5 (a)	Structural steel work in the battery rooms, Chlorination plant and water treatment plant (extreme aggressive atmosphere)	Ambient	Sa 3	Prime	2	P8	30	x	
							30	x	
				Finish	2	F6	100		x
						Total DFT	100		x
							260		
(b)	Un-insulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2	P3	35	x	
							35	x	
				Finish	2	F6	100		x
						Total DFT	100		x
							270		
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35	x	
							35	x	
				Finish	2	F6	100		x
						Total DFT	100		x
							270		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50	x	
							50	x	
				Finish	2	F3	30		x
						Total DFT	30		x
							160		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30	x	
							30	x	
				Finish	3	F7	125		x
							125		x
						Total DFT	125		x
							435		

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				344

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125		x
							125		x
							125		x
							125		x
						Total DFT	500		
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
				Finish	3	F3	50	x	
							30		X
							30		X
						Total DFT	190		X
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
				Finish	2	F6	50	x	
							100		x
							100		x
						Total DFT	300		

3.1.0 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the standard and shall submit for Owner/Owner's representative's approval. (For colour code for piping and fire equipment refer Annexure-1).

(27)

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No. 345

Notes :

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.
2. All primers and finish coats should be cold cured and air dried unless otherwise specified.
3. Selected chlorinated rubber paint should have resistance to corrosive atmosphere and suitable for marine/saline environment.
4. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.
5. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
6. In case of use of epoxy tie coat, manufacturer should demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat (P-9) alternate system may be used taking into consideration the service requirement of the system.
7. All primers should be top coated immediately as per manufacturer's recommendations.
8. In ONGC Hazira complex no sand blasting or shot blasting shall be done. All equipment shall be protected with anti-corrosive coat and after final painting only shifted to project site for further erection. Touch – up painting for the damage area during transportation can be done at project site.

	Subject	Doc. No.	Rev.	Vol. / Sec.
	BID PACKAGE FOR COMBINED CYCLE CAPTIVE POWER PLANT AT HAZIRA PLANT, GUJARAT	5111168-ME-SPC-100-001	R1	III / 2.15
				Sheet No.
				346

3.2.0 Specific Requirement

3.2.1 Following paint schedules shall be followed :

- Acid resistant paint for DM plant building / structure, neutralisation pit, battery room, other corrosive area.
- Synthetic enamel paint for Structural steel, structural sheds, window grills, hand railings, etc.
- Epoxy high build paint for DM plant equipment with piping valves.

3.2.2 All steel work not embedded in concrete to be given one coat of commercial grade zinc chromate primer before painting.

3.2.3 Synthetic enamel paint :

a) General building / structure :

- Surface preparation : ST – 2 according to Swedish standard SIS 055900
- Primer paint : Two coats of Zinc phosphate in phenolic alkyd medium (DFT = 35 microns / coat)
- Finish paint : Two coats of Synthetic enamel (DFT = 25 microns / coat) confirming IS 2932, 1974.

b) Part of steel structure embedded in concrete :

- Surface preparation : ST – 2 according to Swedish standard SIS 055900
One coat of port land cement slurry.

c) Epoxy high building coating:

- Epoxy zinc phosphate primer : two coats of 35 DFT per coat.
- Epoxy high build coating : one coat of 100 DFT.



(24)

SECTION - 4**GUARANTEED TECHNICAL PARAMETERS**

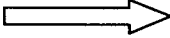
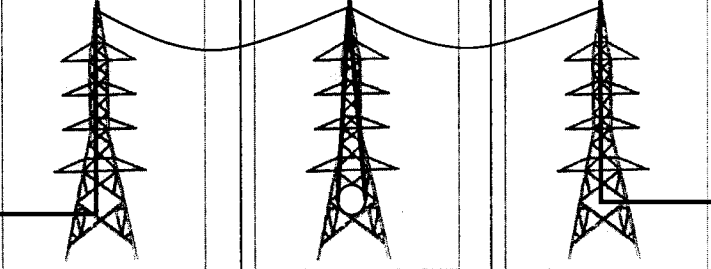
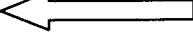
The following sets Sheets are required to be filled up by the Bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same DRS format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures. The DRS forms have been included for the major items, however, the DRS or each item along with sufficient details shall be submitted.

1. OPGW Construction**OPTICAL GROUND WIRE****CABLE CONSTRUCTION**

Seq.	Parameter	Unit	Particulars
1	Fibre Manufacturer Dual Window Single-Mode:		
2	No. of Fibres Dual Window Single-Mode:	each	
3	Buffer Type:		
4	Buffer Tube Diameter:	mm	
5	Buffer Tube material		
6	No. of Buffer Tubes	each	
7	No. of Fibers per Tube	each	
8	Identification/numbering of individual tubes		
9	No. of empty tubes (If any)	each	
10	Filling material		
11	Filling material compliant with technical specifications?	Yes/No	
12	Strength member(s)		
13	Binding yarn/ tape		
14	Describe Central Core Design		
15	20% Aluminum Clad steel wire Diameter: Number:	mm each	
16	Aluminum alloy wires Diameter: Number:	mm each	
17	Aluminum tube inner diameter	mm	
18	Aluminum tube outside diameter	mm	
19	Cable Diameter: (nominal $\pm$ deviation)	mm	
20	Cable cross-section area	Sq. mm	

(9)

SPLICE TEST REPORT FOR OPGW (1550 nm)

Report No.		Line:				
Date:		Section:				
		Tower No:				
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria			
	1550 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice			
Testing Date:						
Direction A  OTDR						Direction B  OTDR
Joint Box		Appearance	Fiber Routing	Sealing	Tower No.	
Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB)		Actual Loss (dB) = (A+B)/2
				Direction-A	Direction-B	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
Tested By			Witnessed By		Approved By	

SPLICE TEST REPORT FOR SPLICING OPGW & APPROACH CABLE (1310 nm)

Report No.		Line:			
Date:		Section:			
		Tower No:			
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria		
	1310 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice		
Testing Date:					

Joint Box	Appearance	Fiber Routing	Sealing	Tower No.
-----------	------------	---------------	---------	-----------

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB)		Actual Loss (dB) = (A+B)/2
				Direction-A	Direction-B	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					

Tested By	Witnessed By	Approved By
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7

SPLICE TEST REPORT FOR SPLICING OPGW & APPROACH CABLE (1550 nm)

Report No.		Line:			
Date:		Section:			
		Tower No:			
Type of OTDR:	Wave Length	Refractive Index	Acceptance criteria		
	1550 nm		Max Splice loss : 0.1 dB (Individual Splice) & Average splice loss in a link 0.05 dB/Splice		
Testing Date:					

Direction A

OTDR

OPGW

Joint Box

Approach cable

Gantry

Control Room

OTDR

Direction B

Joint Box	Appearance	Fiber Routing	Sealing	Tower No.

Tube color	Fiber No.	Fiber color	Splicing Date	Splice Loss (dB)		Actual Loss (dB) = (A+B)/2
				Direction-A	Direction-B	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					

Tested By

Witnessed By

Approved By

FO CABLE END TO END TEST USING OTDR (1310 nm)

Report No.		Line:					
Date:		Section:				FODP TO FODP	
Type of OTDR:		Wave Length	Refractive Index	Max Attenuation			
		1310 nm		(0.35 dB/Km X Total FO length in Km) + (0.05 dB/Splice x Total No. of Splice) + (0.5 dB/Connector x No. of connectors)			
Testing Date:							

Tube color	Fiber No.	Fiber color	Section length (Km)	Attenuation (dB/Km)		Average Attenuation (dB/km) = (A+B)/2	Remarks
				Direction- A	Direction- B		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						

OTDR trace results attached for all fiber (Yes/No) :

Tested By	Witnessed By	Approved By
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5

FO CABLE END TO END TEST USING OTDR (1550 nm)

Report No.		Line:			
Date:		Section:		FODP TO FODP	
Type of OTDR:	Wave Length	Refractive Index	Max Attenuation		
	1550 nm		(0.21 dB/Km X Total FO length in Km) + (0.05 dB/Splice x Total No. of Splice) + (0.5 dB/Connector x No. of connectors)		
Testing Date:					

Tube color	Fiber No.	Fiber color	Section length (Km)	Attenuation (dB/Km)		Average Attenuation (dB/km) = (A+B)/2	Remarks
				Direction- A	Direction- B		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						

OTDR trace results attached for all fiber (Yes/No) :

Tested By	Witnessed By	Approved By
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FO CABLE END TO END TEST USING POWER METER (1310 nm)

Report No.		Line:					
Date:		Section:				FODP TO FODP	
Wave Length		Type of Power Meter:				Reference Power = Pr (dBm):	
1310 nm		Type of Light Source:				A= Power Measuring from 'A' Direction (dBm)	
Testing Date:		P1 = Pr – A dBm P2 = Pr – B dBm				B= Power Measuring from 'B' Direction (dBm)	

Tube color	Fiber No.	Fiber color	Section length (Km)	Received power (dB)		Actual Loss (dB) $P = (P1 + P2) / 2$	Average loss (dB/Km) = $P / \text{Section length}$
				Direction- A (P1)	Direction- B (P2)		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						

Tested By	Witnessed By	Approved By
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FO CABLE END TO END TEST USING POWER METER (1550 nm)

Report No.	Line:						
Date:	Section:					FODP TO FODP	
Wave Length	Type of Power Meter:				Reference Power = P_r (dBm):		
1550 nm	Type of Light Source:				A= Power Measuring from 'A' Direction (dBm)		
Testing Date:	$P_1 = P_r - A$ dBm $P_2 = P_r - B$ dBm				B= Power Measuring from 'B' Direction (dBm)		

Tube color	Fiber No.	Fiber color	Section length (Km)	Received power (dB)		Actual Loss (dB) $P = (P_1 + P_2) / 2$	Average loss (dB/Km) = $P / \text{Section length}$
				Direction- A (P_1)	Direction- B (P_2)		
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						

Tested By	Witnessed By	Approved By
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POWER METER TEST RESULT FOR SECTION:								
Fiber No.	1310 nm			1310 nm			P=(P1 + P2) /2 (dB)	P/Section Length
	Pr (dBm)	A (dBm)	P1 (dBm)	Pr (dBm)	B (dBm)	P2 (dBm)		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
Pr = P ref. for 1310 nm is _____ dBm.								

(1)

GETCO / E / TS – OPGW (24F) 4101/ R5 Dt.07-08-14

POWER METER TEST RESULT FOR SECTION:								
Fiber No.	1550 nm			1550 nm			P=(P1 + P2) /2 (dB)	P/Section Length
	Pr (dBm)	A (dBm)	P1 (dBm)	Pr (dBm)	B (dBm)	P2 (dBm)		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
Pr = P ref. for 1550 nm is _____ dBm.								

Sign and Seal of Bidder

Page 24 of 24
 Page 73 of 73

