

TENDER SPECIFICATION

BHEL: PSSR: SCT: 1438

FOR

Handling at Site Stores / Storage yard, Transportation to Site of Work, Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at

at

**PHASE-3, CPCL MANALI,
CHENNAI, TAMILNADU**

VOLUME –I BOOK - I

TECHNOCOMMERCIAL BID (Book I & II)

Book-I consists of

- **Notice Inviting Tender,**
- **Volume-IA : Technical Conditions of Contract**

Book-II consists of

- **Volume-IB : Special conditions of Contract,**
- **Volume-IC : General conditions of Contract**
- **Volume-ID : Forms & Procedures**



BHARAT HEAVY ELECTRICALS LIMITED

(A Government of India Undertaking)

Power Sector – Southern Region

690, Anna Salai, Nandanam, Chennai – 600 035.

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India Undertaking)
Power Sector, Southern Region
690, Anna Salai, Nandanam, Chennai – 35

Tender Specification No. BHEL: PSSR: SCT: 1438

for

Handling at Site Stores / Storage yard, Transportation to Site of Work, Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at Phase-3, CPCL Manali, Chennai, TamilNadu

One set of Tender documents consisting of

- 1) TECHNOCOMMERCIAL BID - 2 copies
- 2) PRICE BID (Vol II) - 2 copies

Book Sl no

Issued to
M/s

Refer NIT for Last date of submission

Please note this tender document is not transferable

For and on behalf of
BHARAT HEAVY ELECTRICALS LIMITED

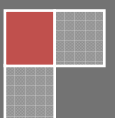
ADDL GENERAL MANAGER / CONTRACTS

Place: Chennai -35
Date:

Rev 00
6th July
2010

NOTICE INVITING TENDER

Bharat Heavy Electricals Limited



NOTICE INVITING TENDER (NIT)

**NOTE: BIDDER MAY DOWNLOAD FROM WEB SITES
OR
PURCHASE TENDERS FROM THIS OFFICE ALSO**

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To

Dear Sir/Madam

Sub : NOTICE INVITING TENDER

Sealed offers in two part bid system are invited from reputed & experienced bidders (meeting [PRE QUALIFICATION CRITERIA](#) as mentioned in Annexure-I) for the subject job by the undersigned on the behalf of BHARAT HEAVY ELECTRICALS LIMITED as per the tender document. Following points relevant to the tender may please be noted and complied with.

1.0 Salient Features of NIT

Sl. No	ISSUE	DESCRIPTION	
i	TENDER NUMBER	BHEL PSSR SCT 1438	
ii	Broad Scope of job	Handling at Site Stores / Storage yard, Transportation to Site of Work, Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at Phase-3, CPCL Manali, Chennai, TamilNadu	
iii	DETAILS OF TENDER DOCUMENT		
a	Volume-IA	<i>Technical Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc</i>	<i>Applicable</i>
b	Volume-IB	<i>Special Conditions of Contract (SCC)</i>	<i>Applicable</i>

c	Volume-IC	<i>General Conditions of Contract (GCC)</i>	<i>Applicable</i>
d	Volume-ID	<i>Forms and Procedures</i>	<i>Applicable</i>
e	Volume-II	<i>Price Schedule (Absolute value).</i>	<i>Applicable</i>
iv	Issue of Tender Documents	<p><u>1.Sale from BHEL PSSR Regional office at :Chennai</u> Start : 08-12-2010 Closes: 21-12-2010 , Time :15.00 Hrs</p> <p>2.From BHEL website (www.bhel.com) Tender documents can however be downloaded from website till due date of submission</p>	<i>Applicable</i>
v	DUE DATE & TIME OF OFFER SUBMISSION	<p><i>Date : 22 /12/ 2010 , Time :15.00Hrs</i> <i>Place : <u>BHEL PSSR :Chennai</u></i> Tenders can be submitted through representative / in person at SCT Dept, BHEL PSSR, Chennai.</p>	<i>Applicable</i>
vi	OPENING OF TENDER	<p><i>Date : 22 /12/ 2010 , Time :15.30Hrs</i> <i>Notes:</i> <i>(1) In case the due date of opening of tender becomes a non-working day, tenders shall be opened on next working day at the same time.</i> <i>(2) Bidder may depute representative to witness the opening of tender</i></p>	<i>Applicable</i>
vii	EMD AMOUNT	<i>Rs 2,00,000/- (Rupees Two Lakhs Only)</i>	<i>Applicable</i>
viii	COST OF TENDER	<i>Rs 2,000/-.</i>	<i>Applicable</i>

ix	LAST DATE FOR SEEKING CLARIFICATION	<i>At least 7 days before the due date of offer submission or two days before the scheduled date of pre-bid meeting whichever is earlier Along with soft version also, addressing to undersigned & to others as per contact address given below</i>	<i>Applicable</i>
x	Schedule of Pre Bid Discussion (PBD)	<i>Date: 15/12/2010. Time 11.00AM at BHEL:PSSR:Chennai-35</i>	<i>Applicable.</i>
xi	INTEGRITY PACT & DETAILS OF INDEPENDENT EXTERNAL MONITOR (IEM)	Bidders shall enter into an Integrity Pact (IP) with BHEL as per format given at Volume 1D Formats of this tender. The bidders are required to return this Integrity Pact (IP) along with Techno Commercial Bid duly signed and stamped by the authorized signatory who signs the bid. It may be noted that only those bidders who have entered into such an IP with BHEL would be competent to participate against this tender .i.e. entering into this pact is a preliminary qualifications for the bidders. The Independent External Monitor against this NIT shall be Shri	<i>Not Applicable</i>
xii	Latest updates	Latest updates on the important dates, Amendments, Correspondences, Corrigenda, Clarifications, Changes, Errata, Modifications, Revisions, etc to Tender Specifications will be hosted in BHEL webpage (www.bhel.com --> Tender Notifications →View Corrigendums) and not in the newspapers. Bidders to keep themselves updated with all such information	

- 2.0 The offer shall be submitted as per the instructions of tender document and as detailed in this NIT. Bidders to note specifically that all pages of tender document, including these NIT pages of this particular tender together with subsequent correspondences shall be submitted by them, duly signed & stamped on each page, as part of offer. Rates/Price including discounts/rebates, if any, mentioned anywhere/in any form in the techno-commercial offer other than the Price Bid, shall not be entertained.
- 3.0 Unless specifically stated otherwise, bidder shall remit cost of tender and courier charges if applicable, in the form of Demand Draft drawn in favour of Bharat Heavy Electricals Ltd, payable at Power Sector Regional HQ at Chennai issuing the Tender, along with techno-commercial offer. Bidder may also choose to deposit the Tender document cost by cash at the Cash Office as stated above against sl no iv of 1, on any working day; and in such case copy of Cash receipt is to be enclosed with the Techno Commercial offer. Sale of tender Documents shall not take place on National Holidays, holidays declared by Central or State Governments and BHEL PS HQ at Chennai, Sundays and second/ last Saturdays
- 4.0 Unless specifically stated otherwise, bidder shall deposit EMD through Demand Draft/Pay Order in favour of Bharat Heavy Electricals Ltd, payable at Chennai. For other details and for 'One Time EMD' please refer General Conditions of Contract.
- 5.0 Procedure for Submission of Tenders: The Tenderers must submit their Tenders to Officer inviting Tender, as detailed below:
- PART-I consisting of 'PART-I A (Techno Commercial Bid)' & 'PART-I B (EMD/COST of TENDER)' in two separate sealed and superscribed envelopes (ENVELOPE-I & ENVELOPE-II)
 - PART-II (Price Bid) – in sealed and superscribed envelope (ENVELOPE-III)
 - One set of each document shall be retained by the bidder for their reference.
- 6.0 The contents for ENVELOPES and the superscription for each sealed cover / Envelope are as given below. (All pages to be signed and stamped)

Sl no	Description	Remarks
	Part-I A	
	<p><u>ENVELOPE – I superscribed as :</u> PART-I (TECHNO COMMERCIAL BID) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: CONTAINING THE FOLLOWING:-</p>	
i.	Covering letter/Offer forwarding letter of Tenderer.	
ii.	<p>Duly filled-in 'No Deviation Certificate' as per prescribed format to be placed after document under sl no (i) above. Note:</p> <p>a. In case of any deviation, the same should be submitted separately for technical & commercial parts, indicating respective clauses of tender against which deviation is taken by bidder. The list of such deviation shall be placed after document under sl no (i) above. It shall be specifically noted that deviation recorded elsewhere shall not be entertained.</p> <p>b. BHEL reserves the right to accept/reject the deviations without assigning any reasons, and BHEL decision is final and binding.</p> <p>i). In case of acceptance of the deviations, appropriate loading shall be done by BHEL</p> <p>ii). In case of unacceptable deviations, BHEL reserves the right to reject the tender.</p>	
iii.	<p>Supporting documents/ annexure/ schedules/ drawing etc as required in line with Pre-Qualification criteria.</p> <p>It shall be specifically noted that all documents as per above shall be indexed properly and credential certificates issued by clients shall distinctly bear the name of organization, contact ph no, FAX no, etc.</p>	
iv.	All Amendments / Correspondences / Corrigenda / Clarifications / Changes / Errata etc pertinent to this NIT.	
v.	Integrity Pact Agreement (Duly signed by the authorized signatory)	If applicable
vi.	Duly filled-in annexures, formats etc as required under this Tender Specification/NIT	
vii.	Notice inviting Tender (NIT)	

viii.	Volume – I A : <u>Technical</u> Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc	
ix.	Volume – I B : Special Conditions of Contract (SCC)	
x.	Volume – I C : General Conditions of Contract (GCC)	
xi.	Volume – I D : Forms & Procedures	
xii.	Volume – II (UNPRICED – without disclosing rates/price, but mentioning only 'QUOTED' or 'UNQUOTED' against each item	
xiii.	Any other details preferred by bidder with proper indexing.	

	PART-I B	
	<p><u>ENVELOPE – II</u> superscribed as: PART-I (EMD/COST of TENDER) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: CONTAINING THE FOLLOWING:-</p>	
i.	<p>1. Earnest Money Deposit (EMD) in the form as indicated in this Tender</p> <p style="text-align: center;"><u>OR</u></p> <p>Documentary evidence for 'One Time EMD' with BHEL PSSR Chennai</p> <p>2. Cost of Tender (Demand Draft or copy of Cash Receipt as the case may be)</p>	

	PART-II	
	PRICE BID consisting of the following shall be enclosed	
	<p><u>ENVELOPE-III</u> superscribed as: PART-II (PRICE BID) TENDER NO : NAME OF WORK : PROJECT: DUE DATE OF SUBMISSION: CONTAINING THE FOLLOWING</p>	
i	Covering letter/Offer forwarding letter of Tenderer enclosed in Part-I	
ii	Volume II – PRICE BID (Duly Filled in Schedule of Rates – rate/price to be entered in words as well as figures)	
	OUTER COVER	

	<p>ENVELOPE-IV (MAIN ENVELOPE / OUTER ENVELOPE) superscribed as: TECHNO-COMMERCIAL BID, PRICE BID & EMD TENDER NO: NAME OF WORK: PROJECT: DUE DATE OF SUBMISSION:</p> <p>CONTAINING THE FOLLOWING:</p>	
i	<ul style="list-style-type: none"> o Envelopes I o Envelopes II o Envelopes III 	

SPECIAL NOTE: All documents/ annexures submitted with the offer shall be properly annexed and placed in respective places of the offer as per enclosure list mentioned in the covering letter. BHEL shall not be responsible for any missing documents.

7.0 No Deviation with respect to tender clauses and no additional clauses/ suggestions/ in Techno-commercial bid/ Price bid shall normally be considered by BHEL. Bidders are requested to positively comply with the same.

8.0 BHEL reserves the right to accept or reject any or all Offers without assigning any reasons thereof. BHEL also reserves the right to cancel the Tender wholly or partly without assigning any reason thereof. Also BHEL shall not entertain any correspondence from bidders in this matter (except for the refund of EMD).

9.0 Assessment of Capacity of Bidders: (Shall be applicable for all Bid Evaluation from 1st Jan 2011)

Bidders capacity for executing the job under tender shall be assessed as per the following:

I. Assigning Weightages (A) for Similar Jobs Under-Execution:
Weightages shall be worked out and assigned based on the average number of Similar Works under execution including works yet to be commenced by the agency, in the following manner:

i). Number of Similar Jobs

- a) No. of jobs in BHEL, PSER : Say 'J'
- b) No. of jobs in BHEL, PSSR : Say 'K'
- c) No. of jobs in BHEL, PSWR : Say 'L'
- d) No. of jobs in BHEL, PSNR : Say 'M'

- e) No. of jobs with other customers* : Say 'N' (*: Other than BHEL PSER, PSSR, PSWR & PSNR)
- f) Average No. of Jobs is 'P' = (J+K+L+M+N) divided by 5

- ii) Weightage "A" assigned to bidders based on Average Number of jobs "P":
 - a) If 'P' = 0-1, "A" will be equal to '3'
 - b) If 'P' = 2-3, "A" will be equal to '2'
 - c) If 'P' = 4-5, "A" will be equal to '1'
 - d) If 'P' is Above 5, "A" will be equal to '0'

II. Weightage "B" for Quarterly Performance Reports of Vendors: This shall be based on the averages of the net weighted score obtained by the bidder for the jobs under execution (excluding works not commenced) for the quarter previous to the last quarter reckoned from the date of latest due date of submission, in all four Regions i.e BHEL PSER, PSSR, PSWR & PSNR, in the following manner.

i). Ratings by Power Sector Region:

- a) PS ER's Rating 'Rer' = $(X_1 + X_2 + \dots + X_n)$
 - b) PS WR's Rating 'Rwr' = $(X_1 + X_2 + \dots + X_n)$
 - c) PS SR's Rating 'Rsr' = $(X_1 + X_2 + \dots + X_n)$
 - d) PS NR's Rating 'Rnr' = $(X_1 + X_2 + \dots + X_n)$
- Over all Power Sector Region Rating ' R_{BHEL} ' = $(Rer + Rwr + Rsr + Rnr)$ divided by $(Ner + Nwr + Nsr + Nnr)$

(where " $X_1, X_2, X_3, \dots, X_n$ " is the net weighted score obtained by the bidder as per the "Evaluation of Contractor Performance (Quarterly)" against the various contracts 'N' under execution in the respective Region).

ii) Weightage "B" assigned to bidders based on Overall Power Sector Rating (R_{BHEL}):

- a) If R_{BHEL} is 80% and above, "B" will be equal to '6'
- b) If R_{BHEL} is $> 70\% < 80\%$, "B" will be equal to '5'
- c) If R_{BHEL} is $> 60\% < 70\%$, "B" will be equal to '4'
- d) If R_{BHEL} is $\leq 60\%$, "B" will be equal to '0'

III. Evaluation of Bidders capacity to execute the job under tender:

shall be based on the sum of scores obtained in 'A' and 'B', as below:

- a) 6 or above : Considered 'Qualified' for the job under tender
- b) Less than 6: Considered 'NOT Qualified' for the job under tender

IV. Explanatory note:

- a) Similar work means Boiler or Turbine or Civil or Electrical or CI, etc as detailed in the scope irrespective of rating of Plant
- b) Quarter shall be as per the quarter defined in the “Evaluation of Contractor performance (Quarterly)”. For contracts where annexed Quarterly Evaluation performance was not part of the contract, ‘Quarterly Performance Reports’ previous to the last quarter reckoned from the date of latest due date of submission, given by the respective project site against the contract will be the basis for evaluation.
- c) Vendors who are not executing any jobs presently in the Region and first timers to the Region, may be considered subject to satisfying all other tender conditions
- d) ‘Under execution’ shall mean works in progress upto Boiler Steam Blowing (for Boiler and Auxilliaries) or Synchronisation (for all other jobs including Civil) shall be considered.

10.0 Since the job shall be executed at site, bidders must visit site/ work area and study the job content, facilities available, availability of materials, prevailing site conditions including law & order situation etc before quoting for this tender. They may also consult this office before submitting their offers, for any clarifications regarding scope of work, facilities available at sites or on terms and conditions. No additional claim shall be entertained by BHEL in future, on account of non-acquaintance of above.

11.0 For any clarification on the tender document, the bidder may seek the same in writing or through e-mail, as per specified format, within the scheduled date for seeking clarification, from the office of the undersigned. BHEL shall not be responsible for receipt of queries after due date of seeking clarification due to postal delay or any other delays. Any clarification / query received after last date for seeking clarification may not be normally entertained by BHEL and no time extension will be given.

12.0 BHEL may decide holding pre-bid discussion [PBD] with all intending bidders as per date indicated in the NIT. The bidder shall ensure participation for the same at the appointed time, date and place as may be decided by BHEL. Bidders shall plan their visit accordingly. The outcome of pre-bid discussion (PBD) shall also form part of tender.

- 13.0 In the event of any conflict between requirement of any clause of this specification/ documents/ drawings/data sheets etc or requirements of different codes/standards specified, the same to be brought to the knowledge of BHEL in writing for clarification before due date of seeking clarification (whichever is applicable), otherwise, interpretation by BHEL shall prevail. Any typing error/missing pages/ other clerical errors in the tender documents, noticed must be pointed out before pre-bid meeting/submission of offer, else BHEL's interpretation shall prevail.
- 14.0 Unless specifically mentioned otherwise, bidder's quoted price shall deemed to be in compliance with tender including PBD.
- 15.0 Bidders shall submit Integrity Pact Agreement (Duly signed by authorized signatory who signs in the offer), if applicable, along with techno-commercial bid. This pact shall be considered as a preliminary qualification for further participation. The names and other details of Independent External Monitor (IEM) for the subject tender is as given at point (xi) of 1 above.
- 16.0 The Bidder has to satisfy the Pre Qualifying Requirements stipulated for this Tender in order to be qualified. The Price Bids of only those bidders will be opened who will be qualified for the subject job on the basis of pre-qualification evaluation/ techno-commercial bids, approval/ acceptance of customer (as applicable), etc. and date of opening of price bids shall be intimated to only such bidders.
- 17.0 In case BHEL decides on a 'Public Opening', the date & time of opening of the sealed PRICE BID shall be intimated to the qualified bidders and in such a case, bidder may depute one authorised representative to witness the price bid opening. BHEL reserves the right to open 'in-camera' the 'PRICE BID' of any or all Unsuccessful / Disqualified bidders under intimation to the respective bidders.
- 18.0 Validity of the offer shall be for six months from the latest due date of offer submission (including extension, if any) or specified otherwise in SCC of tender.
- 19.0 BHEL reserves the right to decide the successful bidder on the basis of Reverse Auction process. In such case all qualified bidders will be intimated regarding procedure/ modality for Reverse Auction process prior to Reverse Auction and price will be decided as per the rules for Reverse Auction. .

However, if reverse auction process is unsuccessful as defined in the RA rules/procedures, or for whatsoever reason, then the sealed 'PRICE BIDS' will be opened for deciding the successful bidder. BHEL's decision in this regard will be final and binding on bidder.

20.0 On submission of offer, further consideration will be subject to compliance to tender & qualifying requirement and customer's acceptance, as applicable.

21.0 In case the bidder is an "Indian Agent of Foreign Principals", 'Agency agreement has to be submitted along with Bid, detailing the role of the agent along with the terms of payment for agency commission in INR, along with supporting documents.

22.0 The bidders shall not enter into any undisclosed M.O.U. or any understanding amongst themselves with respect to tender.

23.0 In case Consortium Bidding is allowed as per Pre Qualifying Requirement, then Prime Bidder and Consortium Partner shall enter into Consortium Agreement. Validity period of Consortium Agreement shall be 6 months after which the same can be re validated.

'Stand alone' bidder cannot become a 'prime bidder' or a 'consortium bidder' in consortium bidding. Prime bidder shall neither be a consortium partner to other prime bidder nor take any other consortium partners. However, consortium partner may enter into consortium agreement with other prime bidders. In case of non compliance, consortium bids of such Prime bidders will be rejected. .

24.0 The bidder shall submit documents in support of possession of 'Qualifying Requirements" duly self certified and stamped by the authorized signatory, indexed and properly linked in the format for PQR. In case BHEL requires any other documents/proofs, these shall be submitted immediately.

25.0 The bidder may have to produce original document for verification if so decided by BHEL.

26.0 Order of Precedence

In the event of any ambiguity or conflict between the Tender Documents, the order of precedence shall be in the order below:

a. **Amendments/Clarifications/Corrigenda/Errata etc issued in respect of the tender documents by BHEL**

- b. Notice Inviting Tender (NIT)
- c. Price Bid
- d. Technical Conditions of Contract (TCC)—Volume-1A
- e. Special Conditions of Contract (SCC) —Volume-1B
- f. General Conditions of Contract (GCC) —Volume-1C
- g. Forms and Procedures —Volume-1D

For BHARAT HEAVY ELECTRICALS LTD

AGM /SCT

Enclosure

01. Annexure-1: Pre Qualifying criteria.
02. Annexure-2: Check List.
- 03 Other Tender documents as per this NIT.

PRE QUALIFYING CRITERIA

JOB	Handling at Site Stores / Storage yard, Transportation to Site of Work, Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at Phase-3, CPCL Manali, Chennai, TamilNadu
TENDER NO	BHEL PSSR SCT 1438

Sl. No	PRE QUALIFICATION CRITERIA	Bidders claim in respect of fulfilling the PQR Criteria	
		Name and Description of qualifying criteria	Page no of supporting document enclosed
A	Submission of Integrity Pact duly signed (if applicable)	Not applicable	
B	Assessment of Capacity of Bidder to execute the work as per sl no 9 of NIT (if applicable)	<u>Shall be applicable for Bid Evaluation from 1st Jan 2011</u>	
C	<u>Technical</u> The Bidder should have successfully completed Erection, Testing and Commissioning of DCS / PLC based TG or GT control or Boiler control or Station C & I system and Electrical systems which includes HT/LT Switch Gear, Transformers of min 2MVA rating and other related works like cabling, impulse piping, field instrumentations etc in the last seven years in any power plant or process/chemical industries.		
D 1	<u>Financial</u> TURNOVER The bidders should have a minimum average financial turnover of Rs 50 Lakhs in last three financial years ending on 31 st March 2010		

2	NETWORTH The bidder should have should have positive net worth as on 31.03.2010		
3	PROFIT The bidder should have earned profit in any one of the last three financial years ending on 31.03.2010		
4	Notwithstanding the above, BHEL reserves the right to reject any or all the tenders for the reasons whatsoever beyond our control and the decision of BHEL is final		
E	Approval of the bidder by Customer (if applicable) Note: Names of bidders who stand qualified after compliance of criteria A to D shall be forwarded to customer for their approval. Price bid of only those bidders shall be opened who are approved by customer.	Applicable	
F	Consortium criteria (if applicable)	Not applicable	
<p>Explanatory Notes for QR 'A'</p> <p>1.The word 'executed' means the bidder should have achieved the criteria specified in the QR even if the total contract has not been completed or closed</p> <p>2.Bidder to submit Audited Balance Sheet and Profit and Loss Account for the respective years as given above along with all annexures</p>			

BIDDER SHALL SUBMIT ABOVE PRE-QUALIFICATION CRITERIA FORMAT, DULY FILLED-IN, SPECIFYING RESPECTIVE ANNEXURE NUMBER AGAINST EACH CRITERIA AND FURNISH RELEVANT DOCUMENT IN THE RESPECTIVE ANNEXURES IN THEIR OFFER.

ANNEXURE - 2

CHECK LIST

NOTE: - Tenderers are required to fill in the following details and no column should be left blank

1	Name and Address of the Tenderer		
2	Details about type of the Firm / Company		
3	Details of Contact person for this Tender	Name : Mr/Ms Designation: Telephone No: Mobile No: Fax No:	
4	EMD DETAILS	DD No: Date : Bank : Amount: <u>Please tick (√) whichever applicable:-</u> ONE TIME EMD / ONLY FOR THIS TENDER	
5	Validity of offer	To be valid for six months from due date	
		APPLICABILITY	BIDDER REPLY
6	Whether the format for compliance with PRE QUALIFICATION CRITERIA (ANNEXURE-I) is understood and filled with proper supporting documents referenced in the specified format	Applicable / Not applicable	YES / NO
7	Audited profit and Loss Account for the last three years submitted	Applicable / Not applicable	YES/NO
8	Copy of PAN Card submitted	Applicable / Not applicable	YES/NO
9	Whether all pages of the Tender documents including annexures, appendices etc are read understood and signed	Applicable / Not applicable	YES/NO
10	Integrity Pact	Applicable / Not applicable	YES/NO
11	Declaration by Authorised Signatory	Applicable / Not applicable	YES/NO

12	No Deviation Certificate	Applicable / Not applicable	YES/NO
13	Declaration confirming knowledge about Site Conditions	Applicable / Not applicable	YES/NO
14	Declaration for relation in BHEL	Applicable / Not applicable	YES/NO
15	Non Disclosure Certificate	Applicable / Not applicable	YES/NO
16	Bank Account Details for E-Payment	Applicable / Not applicable	YES/NO
16	Capacity Evaluation of Bidder for current Tender	Applicable / Not applicable	YES/NO
17	Tie Ups/Consortium Agreement are submitted as per format	Applicable / Not applicable	YES/NO
18	Power of Attorney for Submission of Tender/Signing Contract Agreement	Applicable / Not applicable	YES/NO
19	Analysis of Unit rates	Applicable / Not applicable	YES/NO
20	Unquoted price bid submitted or not	Applicable / Not applicable	YES/NO

NOTE: STRIKE OFF 'YES' OR 'NO', AS APPLICABLE

DATE:

AUTHORISED SIGNATORY
(With Name, Designation and Company seal)

Rev 00
6th July
2010

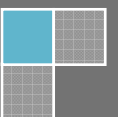
VOLUME – IA

Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

(Document No PS:MSX:TCC)

BHARAT HEAVY ELECTRICALS LIMITED



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PART – I CHAPTER – I PROJECT INFORMATION

01	OWNER	CHENNAI PETROLEIUM CORPARATION LTD
02	PROJECT TITLE	1X 20 MW GTG PROJECT
03	LOCATION	MANALI, CHENNAI. LATITUDE 13deg 04'N LONGTUDE 80 deg 15'E
04	POWER STATION SITE	ELEVATION ABOVE MEAN SEA LEVEL (MSL) : 3.5 MTS
05	NEAREST RAILWAY STATION	CHENNAI CENTRAL (15 KMS)
06	NEAREST CITY	CHENNAI
07	NEAREST AIR PORT	MEENAMBAKKAM AIR PORT (35 KMS)
08	NEAREST SEAPORT	CHENNAI (25 KMS)
09	ROAD APPROACH	AVAILABLE
10	DRY BULB TEMPERATURE	35 deg C
11	RELATIVE HUMIDITY	-+70%
12	ALTITUDE	3.5 M ABOVE MSL
13	AMBIENT RANGE	
14	MEAN AMBIENT TEMPERATURE	18 deg C
15	NORMAL/AVERAGE TEMP	35 deg C
16	MAXIMUM TEMPERATURE	45 deg C
17	RAIN FALL DATA	
18	RAIN FALL FOR 1 HOUR PERIOD	100 mm
19	RAIN FALL FOR 24 HOUR PERIOD	254mm
20	DESIGN WIND SPEED	50m/s AS PER IS: 875 (PART3) FACTOR K1: 1.08 FACTOR K2: FOR TERRAIN CATEGORY 2 FACTOR K3: 1.0

PART – I CHAPTER – II

SCOPE OF WORKS

1.2.1 The scope of work includes Handling at Site Stores / Storage yard, Transportation to Site of Work, Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at Phase-3, CPCL Manali, Chennai, TamilNadu

The scope of the work will comprise of but not limited to the following:

1.2.1.1 Receipt of materials / component to be erected by the contractor, loading and transportation from the storage yard to the project site, stacking, storage and preservation.

1.2.1.2 Erection, Testing, Commissioning, Trial operation and reliability operation of equipment.

1.2.1.3 Final painting including supply of paints.

1.2.1.4 Providing commissioning assistance to BHEL.

1.2.1.5 SCOPE OF WORK IN GENERAL:

The scope of Electrical/C&I work covers GTG, HRSG and BOP areas of 1 X 20 MW CO-GEN CYCLE POWER PLANT, CPCL –CHENNAI (STAGE – III)

The scope of Electrical/C&I work in the plant consists of

- (i) E&C of Electrical Package related to HRSG & Gas Turbine and supply of Electrical materials/ consumables as specified in the tender.
- (ii) E&C of Illumination in GTG & HRSG area and supply of consumables as specified in the tender.
- (iii) E&C of C&I Package related to HRSG & Gas Turbine including supply of consumables as specified in the tender.

1.2.2 PAINTING

The scope of work shall include supply and application of final painting for all the components under the scope of work.

Note:

FOR FURTHER DETAILED SCOPE OF WORKS REFER RELEVANT CHAPTERS IN THIS BOOK

PART – I CHAPTER – III
**FACILITIES IN THE SCOPE OF CONTRACTOR / BHEL
(SCOPE MATRIX)**

SI.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.1.0	PART I ESTABLISHMENT			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		
B	Open space for storage	Yes		
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
D	Bidder's all office equipments, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc		Yes	
F	Fire fighting equipments like buckets, extinguishers etc		Yes	
G	Fencing of storage area, office, canteen etc of the bidder		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space		Yes	
B	Living accommodation		Yes	
1.3.1.2.0	ELECTRICITY			Free of charges
1.3.1.2.1	Electricity For construction purposes (to be specified whether chargeable or free)			
1.3.1.2.1.1	Single point source	Yes		
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
1.3.1.2.2	Electricity for the office, stores, canteen etc of the bidder which include:		Yes	

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
1.3.1.2.2.4	Living facilities for office use including charges		Yes	
1.3.1.2.2.5	Demobilization of the facilities after completion of works		Yes	
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc on the above lines.(in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	
1.3.1.3.0	WATER SUPPLY			Free of charges
1.3.1.3.1	For construction purposes:			
1.3.1.3.1.1	Making the water available at single point	Yes		
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.3.2	Water supply for bidder's office, stores, canteen etc		yes	
1.3.1.3.2.1	Making the water available at single point		Yes	
1.3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.4.0	LIGHTING			

SI.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART I			
1.3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area At the construction site /area		Yes	
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) At office storage area At the preassembly area At the construction site /area		Yes	
1.3.1.5.0	COMMUNICATION FACILITIES for site operations of the bidder	-		
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc		Yes	
1.3.1.6.0	COMPRESSED AIR SUPPLY			
1.3.1.6.1	Supply of Compressor and all other equipments required for compressor & compressed air system including pipes, valves, storage systems etc	-	YES	
1.3.1.6.2	Installation of above system and operation & maintenance of the same	-	YES	
1.3.1.6.3	Supply of the all the consumables for the above system during the contract period		YES	

SI.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART II			
	ERECTION FACILITIES			
1.3.2.1.0	Engineering works for construction			
1.3.2.1.1	Providing the erection drawings for all the equipments covered under this scope	Yes		
1.3.2.1.2	Drawings for construction methods		Yes	In

SI.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART II			consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	”
1.3.2.1.4	Shipping lists etc for reference and planning the activities	Yes	Yes	”
1.3.2.1.5	Preparation of site erection schedules and other input requirements		Yes	”
1.3.2.1.6	Review of performance and revision of site erection schedules in order to achieve the end dates and other commitments		Yes	
1.3.2.1.7	Weekly erection schedules based on SI No 2.1.5		Yes	
1.3.2.1.8	Daily erection / work plan based on SI No 2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	
1.3.2.1.10	Preparation of preassembly bay			
1.3.2.1.11	Laying of racks for gantry crane if provided by BHEL or brought by the contractor/bidder himself			

1.3.3 OPEN SPACE:

Open space for building of temporary office shed, contractor's stores shed(s) will be provided free of hire charges. Contractor has to make his own arrangements for labour colony.

1.3.4 **ELECTRICITY:**

- 1.3.4.1 Electricity for construction will be provided free of charge at one single point. Further distribution of Electricity will be arranged by the contractor at his cost.
- 1.3.4.2 Any duty, deposit involved in getting the Electricity shall be borne by the bidder. As regards contractor's office shed also all such expenditure shall be borne by the contractor.
- 1.3.4.3 Provision of distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cables and cable laying including supply of all materials like cables, switch boards, pipes etc., observing the safety rules laid down by electrical authority of the State / BHEL / their customer with appropriate statutory requirements shall be the responsibility of the tenderer / contractor.
- 1.3.4.4 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.

1.3.5 **WATER:**

Water for construction will be provided free of charge at one single point. Further distribution shall be arranged by the contractor at his cost.

PART – I CHAPTER – IV

T&PS and MMEs TO BE DEPLOYED BY CONTRACTOR

- 1.4.0 The following minimum Tools & Plants shall be deployed by the contractor:**
All T & Ps, Consumables such as Electrodes, Gases, Ferrules, lugs (for sizes upto 2.5 sq mm) etc., and testing instruments and tools are to be arranged by the contractor at his cost.

PART – I CHAPTER – V

T&Ps AND MMEs TO BE DEPLOYED BY BHEL ON SHARING BASIS

No T&P's will provided by BHEL for this scope of work

PART – I CHAPTER-VI
TIME SCHEDULE

1.6.1 **TIME SCHEDULE**

1.6.1.1 The entire work of Erection, Testing and Commissioning of Electrical and Controls & Instrumentation works for 1x20MW CPP at Phase-3, CPCL Manali, Chennai, TamilNadu as detailed in the Tender Specification shall be completed within **8 (eight) months** from the date of commencement of work at site.

1.6.1.2 During the total period of contract, the contractor has to carryout the activities in a phased manner as required by BHEL and the program of milestone events.

1.6.1.3 The erection work shall be commenced as may be stipulated in the letter of intent and shall be deemed as completed in all respect only when the unit is in operation. The decision of BHEL in this regard shall be final and binding of the contractor.

1.6.2 **COMMENCEMENT OF CONTRACT PERIOD**

The date of commencement of contract period shall be the mutually agreed date between bidder and BHEL Engineer to start the work. Incase of discrepancy, BHEL decision is final.

1.6.3 **MOBILISATION FOR ERECTION, TESTING, ASSISTANCE FOR COMMISSIONING ETC.,**

The activities for erection, testing etc shall be started as per directions of BHEL engineer.

The contractor has to augment his resources in such a manner that following tentative dates of major milestones of erection & commission are achieved on specified schedules:

MAJOR MILESTONES

ERECTION START : DEC'2010 (Expected)

FSNL/Synchronization of GT: March-2011

HRSG Commissioning: April 2011

Naphtha Firing/Full Load: June 2011

1.6.4 In order to meet above schedule in general, and any other intermediate targets set to meet customer / project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

1.6.5 In case the project is to be advanced, the erection works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.5 **CONTRACT PERIOD**

The contract period for completion of entire work under scope shall be **8 (eight) months** from the "START OF CONTRACT PERIOD" as specified earlier.

PART – I CHAPTER-VII
TERMS OF PAYMENT

The progressive payment for erection, testing and commissioning on accepted price of contract value will be released as per the break up given hereinafter

1.7 Terms of payment :

1.7.1 Progressive Payment against monthly running bills will be made upto 85 % of the value of the erected tonnage Pro rata as per the following table.

1.7.2 Further 15 % payment on pro-rata basis common to all shall be released on achievement of the following stage / milestones events as per the following table for the tonnage erected.

<u>TERMS OF PAYMENT FOR ELECTRICAL,C&I</u>		
Sl. No.	Activity/Work Description	% of unit rate
A	Main E&C Equipments/Items	
I	PRO RATA PAYMENTS (85%)	
1.7.3.0	Cable tray and accessories	
1.7.3.1	Fabrication and fixing/welding/bolting in position	60%
1.7.3.2	Earthing of cable trays	15%
1.7.3.3	Tagging of cable trays (painting cable tray numbers on sides)	5%
1.7.3.4	Covering of trays where ever envisaged	5%
	Total =	85%
1.7.4.0	Cable laying (Power Cables)	
1.7.4.1	Laying of cables	45%
1.7.4.2	Glanding, Termination and tagging of cables	15%
1.7.4.3	Dressing and clamping of cables	10%
1.7.4.4	Testing and charging of cables	15%
	Total =	85%
1.7.5.0	Cable laying (Control and Signal Cables)	
1.7.5.1	Laying of cables	45%
1.7.5.2	Glanding, Termination and tagging of cables	15%
1.7.5.3	Dressing and clamping of cables	10%
1.7.5.4	Shielding of cables	5%
1.7.5.5	Testing and charging of cables	10%
	Total =	85%
1.7.6.0	Junction box/Push button station (local)	
1.7.6.1	Erection including fixing of terminal blocks where ever applicable	75%
1.7.6.2	Name plate fixing where ever applicable , Labelling (both inside and outside) and Commissioning of connected equipment	10%
	Total =	85%
1.7.7.0	Conduits/impulse pipe/tubes/GI PIPES/HOSES	
1.7.7.1	Fabrication, Laying and Erection	50%

1.7.7.2	Leak Test/Hydraulic Test (where ever applicable, otherwise clubbed with next activity)	20%
1.7.7.3	Dressing, clamping, tagging and painting where ever applicable	8%
1.7.7.4	Testing & commissioning of associated equipment/system	7%
	Total =	85%
1.7.8.0	Miscellaneous Structural steel including frames for Panels/Racks/Instruments, Local/Field Instruments, supports for cable tray/pipes/tubes, Canopies etc	
1.7.8.1	Fabrication, Erection, Alignment , Welding/bolting and where ever applicable chipping/grouting/painting	65%
1.7.8.2	Erection of associated Items/Equipments/Systems as applicable	20%
	Total =	85%
1.7.9.0	Panels/Cubicles/Desks/Racks/Enclosures/Monitors/Computers/Computer peripherals/PLCs/UPS/Batteries/MCC	
1.7.9.1	Erection and alignment	50%
1.7.9.2	Fixing of loose items/instruments where ever applicable	5%
1.7.9.3	Pre commissioning checks, Charging of panel and Loop testing etc	15%
1.7.9.4	System commissioning	15%
	Total =	85%
1.7.10.0	Instruments/Devices including Sensors/Cells/Probes etc	
1.7.10.1	Calibration/Testing/Pre erection checks	30%
1.7.10.2	Erection/Placement and fixing of loose items/accessories	30%
1.7.10.3	Pre commissioning checks/loop testing/Simulation testing as required	10%
1.7.10.4	Remote/local commissioning as required	15%
	Total =	85%
1.7.11.0	Commissioning and Testing activities for Equipments erected by other agencies, like control valves, on/off valves, electrical/pneumatic valves, actuators, solenoid valves, valves, limit switches, ERV controllers, power cylinders, Pressure & Temperature Gauges/Transmitters,etc	
1.7.11.1	Removal & refixing/Fixing loose supplied components, including tubing/hose, regulators, etc	30%
1.7.11.2	Calibration/Local testing - commissioning readiness	30%
1.7.11.3	Local Commissioning & Loop Testing as required	10%
1.7.11.4	System Commissioning or Remote Commissioning as required	15%
	Total =	85%
1.7.12.0	Power Cylinders	
1.7.12.1	Erection and alignment of Power Cylinders	30%
1.7.12.2	Fixing of loose items and Commissioning readiness	30%
1.7.12.3	Loop Checking, Calibration and Local commissioning	20%
1.7.12.4	System/Remote commissioning as required	5%
	Total =	85%

1.7.13.0	Transformers/Switch Gears/Bus ducts with associated equipment	
1.7.13.1	Erection	50%
1.7.13.2	Alignment	10%
1.7.13.3	Testing	15%
1.7.13.4	Completion	10%
	Total =	85%
1.7.14.0	Supply of items	
1.7.14.1	On submission of running bill along with the Stores Receipt Voucher/ Stores' Endorsement issued by BHEL , on pro rata basis	85%
	Total =	85%
1.7.15.0	Miscellaneous items (items not covered under above heads)	
1.7.15.1	Erection	50%
1.7.15.2	Alignment	10%
1.7.151.3	Testing	15%
1.7.15.4	Completion	10%
	Total =	85%
II	STAGE/MILESTONE PAYMENTS (15%)	
1.7.16.1	ABO/Chemical cleaning	1%
1.7.16.2	Steam Blowing	0%
1.7.16.3	Safety Valve Floating	1%
1.7.16.4	Oil Flushing GTG	0%
1.7.16.5	Barring Gear	0%
1.7.16.6	Cranking	0%
1.7.16.7	FSNL	1%
1.7.16.8	Synchronization	1%
1.7.16.9	Full Load	2%
1.7.16.10	Trial Operation of Unit	3%
1.7.16.11	Painting	1%
1.7.16.12	Area cleaning, temporary structures cutting/removal and return of scrap	1%
1.7.16.13	Punch List points/pending points liquidation	1%
1.7.16.14	Submission of 'As Built Drawings'	1%
1.7.16.15	Material Reconciliation	1%
1.7.16.16	Completion of Contractual Obligation	1%
	Total for Milestone/Stage payments (15%)	15%
	Total	100%

1.7.17.0 GUARANTEE PERIOD:-

Guarantee period of 12 months shall commence from the date of handing over of the unit to customer or 6 months from the date of first synchronization of the set whichever is earlier, (Provided all erection, testing and commissioning works are completed in all respects.)

Note:

1. Recovery of Retention amount as per Cl. 2.22 of GCC.
2. RA bill payments as per Chapter-X of SCC
3. Payment for the first running bill will be released only on production of the following.
 - i. PF Regn. No.
 - ii. Labour License No.
 - iii. Workmen Insurance Policy No.
 - iv. Unqualified Acceptance for Detailed L.O.I.
 - v. Initial 50% Security Deposit **AS PER CL 1.10 OF GCC.**
 - vi. Rs 100 /- Stamp Paper for Preparation of Contract agreement.

PART – I CHAPTER VIII
TAXES AND OTHER DUTIES

1.8.0 TAXES

1.8.1 Value Added Tax (VAT) for the works

1.8.1.1 Price quoted shall be inclusive of VAT except service tax.

1.8.1.2 Notwithstanding the fact that this is only an erection service contract not involving any transfer of materials whatsoever and not attracting VAT liability, being labour oriented job work, for the purpose of VAT the contractor has to maintain the complete data relating to the expenditure incurred towards wages etc. in respect of the staff/workers employed for this work as also details of purchase of materials like consumables, spares etc., inter alia indicating the name of the supplier, address and VAT Registration No. and VAT paid for the purchases, etc

1.8.1.3 The bidder shall get registered with State VAT authorities and the registration certificate shall be forwarded to BHEL immediately after commencement of work. In case the bidder had already registered under respective State VAT, they must quote their registration Number and forward copy of Registration Certificate while submitting this tender.

1.8.1.4 The monthly/quarterly VAT return, duly incorporating the erection income from BHEL as turnover, should be submitted to BHEL at regular intervals with all annexure and details of payment of VAT (WCT).

1.8.1.5 You have to obtain VAT Clearance Certificate from the on concerned authorities as per the provisions of local VAT act, on completion of the project and submit along with the final bill.

1.8.1.6 The bidder shall quote very competitive price after taking into consideration of above points.

1.8.2.0 Service Tax

1.8.2.1. Price quoted shall be exclusive of Service Tax. The service tax as statutorily leviable and payable by the bidder under the provisions of service tax Law / Act shall be paid by BHEL as per bidder claim through various running bills. The bidder shall furnish proof of service tax registration with Central Excise Department specifying the name of services covered under this contract. Registration Certificate should also bear the endorsement for the premises from where the billing shall be done by the bidder on BHEL for this project. The bidder shall obtain prior consent of BHEL before billing the service tax amount.

1.8.3.0 Other Taxes & Levies

1.8.3.1 Any other taxes and duties (except VAT & Service Tax) if any, as applicable, viz. Entry Tax, Octroi, Licenses, Deposits, Royalty, Stamp Duty, other charges / levies, etc. prevailing / applicable on the date of opening of technical bids and any variation thereof during the tenure of the contract are in the scope of bidder. In case BHEL is forced to pay any such taxes, BHEL shall have the right to recover the same from the bidder either from running bills or otherwise as deemed fit.

1.8.4.0 New Levies / Taxes

1.8.4.1 In case Government imposes any new levy / tax after award of the work during the tenure of the contract, BHEL shall reimburse the same at actual on submission of documentary proof of payment subject to the satisfaction of BHEL that such new levy / tax is applicable to this contract..

1.8.5.0 Statutory variations

1.8.5.1 Statutory variations are applicable only in the cases of Value Added Tax and Service Tax. The changes implemented by the Central / State Government in the VAT Act / Service Tax during the tenure of the contract viz. increase / decrease in the rate of taxes, applicability, etc. and its impact on upward revision / downward revision are to be suitably paid/ adjusted from the date of respective variation. The bidder shall give the benefit of downward revision in favour of BHEL. No other variations shall be allowed during the tenure of the contract.

1.8.6.0 Direct Tax

1.8.6.1 BHEL shall not be liable towards Income Tax of whatever nature including variations thereof arising out of this contract as well as tax liability of the bidder and their personnel. Deduction of tax at source at the prevailing rates shall be effected by BHEL before release of payment as a statutory obligation, unless exemption certificate is produced by the bidder. TDS certificate will be issued by BHEL as per the provisions of Income Tax Act.

PART – I CHAPTER – IX BILL OF MATERIALS

1 X 20 MW CO-GEN CYCLE POWER PLANT, CPCL –CHENNAI (PHASE – III)

BILL OF MATERIALS FOR ELECTRICAL/ C&I / ILLUMINATION PACKAGE

BOM REF	Description	Qty	Remarks												
A1.0	GENERATOR TRANSFORMER														
A 1.1	<p>33.5 MVA, 11kV/7.07 kV, ONAF/ONAN Generator Transformer complete with NGR, off load tap changer, neutral side CTs, HV/LV/HVN bushings, bushing CTs, radiators, cooling fans, conservators, marshalling panels, pipings etc.</p> <p>Loose items like raise/lower PBs, tap changer indicators, facia windows, W.T.I. repeaters, buzzers, signal lamps, etc. will be supplied loose, to be mounted and wired in control panel.</p> <p>Max. Approximate Dimension: 4400 x 4400 x 5400 mm</p> <p>Approximate weights</p> <table border="0"> <tr> <td>Tank & fittings</td> <td>13,000 kg</td> </tr> <tr> <td>Core & winding</td> <td>27,000 kg</td> </tr> <tr> <td>Total wt of transformer</td> <td>81,000 kg</td> </tr> <tr> <td>Untanking Weight</td> <td>27,000 kg</td> </tr> <tr> <td>Shipping weight(Gas Filled)</td> <td>40,000 kg</td> </tr> <tr> <td>Total oil (24,500 lts)</td> <td>22,000 kg</td> </tr> </table> <p>Approximate Dimension of NGR: 1500 x 1500 x 1000 mm; Weight: 250 kg</p> <p>* Lumpsum rate to be quoted including final painting</p>	Tank & fittings	13,000 kg	Core & winding	27,000 kg	Total wt of transformer	81,000 kg	Untanking Weight	27,000 kg	Shipping weight(Gas Filled)	40,000 kg	Total oil (24,500 lts)	22,000 kg	1 No.	
Tank & fittings	13,000 kg														
Core & winding	27,000 kg														
Total wt of transformer	81,000 kg														
Untanking Weight	27,000 kg														
Shipping weight(Gas Filled)	40,000 kg														
Total oil (24,500 lts)	22,000 kg														
B1.0	6.6 KV HT Switchgear Panels														
B1.1	<p>6.6 KV HT Switchgear-6.6 KV, indoor, metal clad, vacuum break switchgears with incomer ,outgoing feeders, B/C, Bus PT cubicle along with associated loose items, Earthing trucks etc.</p> <p>Switchgear consists of 32 Panels in suitable shipping sections</p> <p>Approximate Dimension of each Panel: 820 (W) x 2695 (H) x2660 (Max-Depth) mm.</p> <p>Weight of Shipping section for 1 Panel: 1500 kg Weight of Shipping section for 2 Panels: 3000 kg</p> <p>*Lump sum rate to be quoted</p> <p>Overall Approximate length of the entire board is approximately 27000 mm</p>	1 set													
C1.0	ELECTRICAL C&I PACKAGE OF BHEL(HYD)- BOP/EM/GT														

C1.1	<p>11 KV SEGREGATED PHASE BUSDUCT FOR GTG</p> <p>11 kV, 2000 A, segregated phase bus ducts for GTG with PTSP Cubicle, NG Cubicle, Cable Panel, Phase & neutral side CTs, Line/Neutral Side open busbars, support structures, air drying equipment with accessories etc.</p> <p>Approximate Dimension & weights</p> <p>Size of Main Busduct Enclosure: 1250 x 450 mm;</p> <p>Approx. length of main Busduct on Phase Side: 16 Mtrs</p> <p>Size of Tap-Off Busduct Enclosure to PTSP Cubicle: 1250 x 400 mm; approximate length : 4 Mtrs</p> <p>Length of busducts on Neutral Side: Approximate Dimension 400 X 400 Mm : approximate length 8 Mtrs</p> <p>Weight of Support structure - 2 Tons</p> <p>PTSP Cubicle & Cable Panel :2700 x 1750 x 2500 mm; 1500 kg (approx)</p> <p>NG Cubicle: 2300 x 1200 x 1200 mm; 750 kg (approx)</p>	1 set	
C1.2	<p>6.6 KV SEGREGATED PHASE BUSDUCT</p> <p>3150A, 6.6kV, 50HZ,</p> <p>CR Enclosure, TP, Phase segregated Bus Duct (Indoor & Outdoor)</p> <p>Size of the bus duct ; 1200x800</p> <p>Approximate Weight of Bus duct 120 kg/m. Including erection of Support structures.</p>	18 metres	
C1.3	<p>415 Volts LT BUS DUCT</p> <p>3200A, 415V, 50HZ</p> <p>Enclosure, TPN, Non Phase Segregated Bus duct (Indoor & Outdoor)</p> <p>Size of the bus duct ; 1200x800mm</p> <p>Approximate weight of Busduct 100 kg/m. Including erection of Support structures.</p>	50 metres	
C1.4	<p>Station Auxiliary Transformer</p> <p>2.5MVA, ONAN, 6.6/0.433 kV,</p> <p>Approximate dimension: 3375x3050x3275mm.</p> <p>Approximate Weight : 8000 kg.</p> <p>Oil Qty: 1400ltrs</p> <p>* Lumpsum rate to be quoted including final painting</p>	2 nos	
C1.5	<p>Station lighting transformer</p> <p>125 kVA, 415/433 V,</p> <p>Approximate dimension: 1500x800x1900 mm,</p> <p>Approximate Weight: 900 kgs</p>	2 nos	

C1.6	Emergency lighting transformer 25kVA,415/433V, Approximate dimension:1000x650x1000, Approximate Weight:350 kgs	1 Set	
C1.7	Generator Control Panel ApproximateSize: 2000 x 950 x 2286 mm ApproximateWeight: 1000 kg	1 No.	
C1.8	Generator Relay Panel with discrepancy recorder, PC etc. ApproximateSize: 1800 x 950 x 2286 mm ApproximateWeight : 1000 kg	1 No.	
C1.9	LT PCC 415 Volts ,3 Phase LT PCC with ACB's , Outgoing SFU's Etc. Approximate Dimension :15000x1500x2430 Approximate Weight :20000 Kgs	1 No.	
C1.10	GT MCC 415 V, 3 phase Approximate Dimension: 10000x1300x2430 mm, in suitable shipping sections ApproximateWeight: 10000 kg	1 no.	
C1.11	BOP MCC 415 V,3 Phase. Approximate Dimension: 15580x1210x2430 mm Approximate weight: 10,000 kg	1 no.	
C1.12	AC VENT MCC 415 V,3 Phase. Approximate Dimension:13600x900x2430, Approximate weight: 17000 kgs	1 no.	
C1.13	HRSG MCC 415 Volts,3 phase Approximate Dimension: 8000x900x2430, Approximate weight :10000 Kgs	1 No.	
C1.14	GT DCDB, 125 V DC Approximate Size: 4000 x 650 x 2430 mm Approximate weight: 1700 kg	1 no.	

C1.15	STN DCDB 110 V DC Approximate Dimension : 6400 x 950 x 2430 mm Approximate weight : 6,000 kg	1 No.	
C1.16	UPS DB 110 V AC Approximate Dimension :4800 x 950 x 2430 mm Approximate weight :4,200 kg	1 no.	
C1.17	MLDB 415 volts,3 Phase Approximate Dimension :4000x950x2430 , Approximate weight :3500kgs	1 No.	
C1.18	ELDB 415 volts, Approximate Dimension :2400x950x2430 , Approximate weight :2100 kgs	1 No.	
C1.19	SCADA Marshalling Panel Approximate Dimension: 1000 x 800 x 2200 mm Approximate weight: 370 kg	1 No.	
C1.20	Electrical control panel (ECP Panel) approximate dimension 5500x1000x2400 , 5000 kgs	1 No.	
C1.21	BATTERY/ BATTERY CHARGER - 125 Volts DC system 125 V DC, G.T. DC system Main and Standby, float cum boost chargers, along with 350 AH, Ni-Cd batteries including discharge resistor, mounting racks and accessories. Size of battery charger: 2000 x 1000 x 2200 mm; 300 kg Total Size of batteries with racks: 8000 x 410 x 1400 mm; 1835 kg Approximate No. of cells : 98	1 No.	
C1.22	BATTERY/ BATTERY CHARGER - 110 Volts DC system 110 V DC, G.T. DC system Main and Standby, 375 Amps,float cum boost chargers, along with 1560 AH, Ni-Cd batteries including discharge resistor, mounting racks and accessories. Size of battery charger: 4000 x 800 x 2200 mm; 2000 kg Total Size of batteries with racks: 5000 x 950 x 1400 mm; total weight 13000 kgs Approximate No. of cells : 87	2 sets	

C1.23	40 KVA, 110 V UPS unit comprising of inverter, chargers, servo stabiliser, etc. Approximate Size: 6000 x 800 x 2000 mm; 2200 kg UPS battery Ni Cd Battery made up of around 400 Nos. cells, along with rack etc. Approximate Size: 6000 x 3000 x 3000 mm; 5000 kg	1 set	
C1.24	MICROPROCESSOR BASED CO2 FIRE FIGHTING PANEL TO BE MOUNTED IN CONTROL ROOM Approximate dimension - 1000x 600x1800 mm Approximate weight - 200 Kgs	1 set	
C1.25	INLET AIR FILTER PANEL Approximate dimension :660 X 255 X 1015 Approximate weight - 100 Kgs	1 set	
C1.26	GT AUXILIARY PANEL - Approximate dimension - 1000x 915x2400 mm Approximate weight - 1000 Kgs	1 set	
C1.27	Vibration Monitoring system for GTG consisting of the following BNC 3500 system work station & vibration monitor along with 8 nos shaft vibration probes, proximators, interconnecting cables etc. The vibration monitor is to be mounted in GT Auxilliary panel	1 set	
C1.28	Haz. Gas Monitor (110 V,ac) to be mounted on GT Aux Panel, 280X290X133	4 No	
C1.29	Start/ Stop Push Button Stations without ammeters (Weatherproof/Explosion proof) 280 x 100 x 300 mm; 5 kg each	46 nos	
C1.30	Start/ Stop Push Button Stations with ammeters (Weatherproof/Explosion proof) 300 x 100 x 500 mm; 5 kg each	20 Nos	
C1.31	Emergency Stop Push Button (Weatherproof) 300 x 100 x 500 mm; 5 kg each	5 Nos	
C2.0	HT Cables		
C2.1	1C x 630Sq.mm., kV (UE) Armoured; Aluminium Conductor ,XLPE insulated PVC/FRLS outer sheathed cable.	1200 mtrs	
C2.2	HT Termination kit for 1C x 630Sq.mm., 11kV (UE) Armoured; Aluminium Conductor XLPE insulated PVC/FRLS,outer sheathed cable.	24 Nos	
C2.3	3C x 185Sq.mm. , 6.6kV (UE) Armoured; Aluminium Conductor ;XLPE insulated PVC/FRLS outer sheathed cable.	700 mtrs	
C2.4	HT Termination kit for 3C x 185Sq.mm. 6.6 kV (UE) Armoured; Aluminium Conductor; XLPE insulated PVC/FRLS,outer sheathed cable	20 Nos	

C3.0	Laying of LT Power Cables (1.1 kv Armoured Cu/Al. Conductor XLPE Insulated PVC/FRLS Outer sheathed)		
C3.1	1 C X 300 sq. mm, Cu	300 mtrs	
C3.2	1 C X 240 sq. mm, Cu	300 mtrs	
C3.3	1 C X 120 sq. mm, Cu	300 mtrs	
C3.4	1 C X 70 sq. mm, Cu	200 mtrs	
C3.5	1 C X 35 sq. mm, Cu	500 mtrs	
C3.6	2 C X 4 sq. mm, Cu	200 mtrs	
C3.7	3 C X 50 sq. mm, Al	400 mtrs	
C3.8	3 C X 35 sq. mm, Al	1000 mtrs	
C3.9	3 C X 16 sq. mm, Cu	2500 mtrs	
C3.10	3 C X 10 sq. mm, Cu	1500 mtrs	
C3.11	3 C X 6 sq. mm, Cu	4000 mtrs	
C3.12	3 C X 4 sq. mm, Cu	3500 mtrs	
C3.13	3 C X 2.5 sq. mm, Cu	15000 mtrs	
C3.14	3.5 C X 300 sq. mm, Al	500 mtrs	
C3.15	3.5 C X 185 sq. mm, Al	500mtrs	
C3.16	3.5 C X 95 sq. mm, Al	1500 mtrs	
C3.17	3.5 C X 50 sq. mm, Al	500 mtrs	
C3.18	3.5 C X 35 sq. mm, Al	1000 mtrs	
C3.19	4 C X 16 sq. mm, Cu	700 mtrs	
C3.20	4 C X 10 sq. mm, Cu	700 mtrs	
C3.21	4 C X 6 sq. mm, Cu	1000 mtrs	
	Termination of Following LT power cables (Separate termination rate is applicable for these cables only. For other power cables termination is part of laying work)		
C3.22	1 C X 70 sq. mm, Cu	10 Nos	
C3.23	1 C X 120 sq. mm	10 nos	
C3.24	1 C X 240 sq. mm, Cu	10 Nos	
C3.25	1 C X 300 sq. mm, Cu	10 Nos	
C3.26	3 C X 50 sq. mm, Al	20 Nos	
C3.27	3.5 C X 50 sq. mm, Al	20 Nos	
C3.28	3.5 C X 95 sq. mm, Al	20 Nos	
C3.29	3.5 C X 185 sq. mm, Al	20 Nos	
C3.30	3.5 C X 300 sq. mm, Al	20 Nos	
C4.0	Laying and termination of Control & Signal Cables (1.1 kv, Cu Armoured PVC insulated PVC/FRLS Outer Sheathed)		
C4.1	3 C X 2.5 sq. mm	15000 mtrs	
C4.2	5 C X 2.5 sq. mm	8000 mtrs	
C4.3	7 C X 2.5 sq. mm	10000 mtrs	
C4.4	10 C X 2.5 sq. mm	11000 mtrs	
C4.5	12 C X 2.5 sq. mm	13500mtrs	

C4.6	16 C X 2.5 sq. mm	3000 mtrs	
C4.7	19 C X 2.5 sq.mm	2500 mtrs	
C4.8	24 C X 2.5 sq.mm	1000 mtrs	
C4.9	10 T X 0.5 sq.mm	1000 mtrs	
C5.0	Pre-fabricated cable trays		
C5.1	Ladder type cable tray, W=600 mm	3000 mtrs	
C5.2	Ladder type cable tray, W=300 mm	1500 mtrs	
C5.3	600 mm (W) perforated cable tray	1450 mtrs	
C5.4	300 mm (W) perforated cable tray	1000 mtrs	
C5.5	150 mm (W) perforated cable tray	625 mtrs	
C5.6	50 mm (W) perforated cable tray	625 mtrs	
C6.0	Structural Steels		
C6.1	ISMC 100 X 50 X 6 mm Channels	38 MT	
C6.2	ISA 65 X 65X 6 mm Runner angles	12 MT	
C6.3	ISA 50 X 50X 6 mm Runner angles	8.5 MT	
C7.0	Plant Earthing & Lightning Protection Materials		
C7.1	75 X 10 mm GI Strips	500 mtrs	
C7.2	50 X 6 mm GI Strips	500 mtrs	
C7.3	35 X 6 mm GI Strips	500 mtrs	
C7.4	8 SWG GI Wire	250 mtrs	
C7.5	16 SWG GI Wire (stranded)	100 mtrs	
C8.0	Plant Illumination Package		
C8.1	Well glass luminaire along with non integral control gear box suitable for the use with HPMV 125 W lamps(IP 66) including fixing of lamps	50 nos	
C8.2	Flameproof Well glass luminaire suitable for hazardous area Group IIA & IIB Zone 2 along with non integral gear box suitable for use with HPMV 125 W lamp(IP 65) including fixing of lamps	20 nos	
C8.3	Well glass luminaire along with non integral control gear box suitable for the use with HPMV 100 W lamps(IP 65) including fixing of lamps	20 nos	
C8.4	2 meter pole along with accessories	80 nos	
C8.5	Industrial metal clad type 6/16A socket with switch	5 nos	
C8.6	Flameproof Well Industrial metal clad type 5/15A socket with switch suitable for hazardous area group IIA & IIB Zone 2	5 nos	
C8.7	63A TPN welding receptables (safe area)	5 nos	
C8.8	63A TPN welding receptables (flameproof area)	5 nos	
C8.9	6 way AC Outdoor Lighting Panels (apprx. Dimension 1000X800X200), apprx. 30kg	2 nos	

C8.10	12 way AC Outdoor Lighting Panels (apprx. Dimension 1000X800X200), apprx. 30kg	1 no	
C8.11	6 way DC Outdoor Lighting Panels	1 no	
C8.12	20 mm dia. GI Conduit	200 mtrs	
C8.13	50 mm dia. GI Conduit	200 mtrs	
C8.14	Lighting JB 3 way/4 way	20 nos	
C8.15	HRSG Stack Lighting- Aviation lamps and lighting arrestor package consisting of the following aviation lamp assembly-4 nos, 50 mm dia GI Pipe -15 mtrs, 34X3.25 dia GI Conduits with accessories -100 mtrs, SFU 32 A-1 no, 2C 2.5 sq.mm PVC Cable-175 mtrs, JB -2 Nos,	1 set	
C8.16	GT Stack Lighting- Aviation lamps and lighting arrestor package consisting of the following aviation lamp assembly-4 nos, 50 mm dia GI Pipe -15 mtrs, 34X3.25 dia GI Conduits with accessories -100 mtrs, SFU 32 A-1 no, 2C 2.5 sq.mm PVC Cable-175 mtrs, JB -2 Nos.	1 set	
C8.17	GT Enclosure Lightning Fixing of around 14 nos explosion proof light fittings, 2 no JB's, .75/1 ' GI Conduits of lenth 50 mtrs , wiring from JB's to fittings, earthing of fittings, control switches etc in accessory module GT Compartment, Generator compartment, offbase compartment	1 set	
C9.0	Miscellaneous Items		
C9.1	MCT Frames WITH MULTI SIZE BLOCKS	40 sq m.	
C9.2	Fire break coatings for HT/LT power cables	50sq.m	
C9.3	Fire proof material for sealing of wall/floor openings and panel boards	50 sq.m	
C9.4	Fire proof material for sealing of cable entry through conduits/trenches	50 sq.m	
C9.5	GI conduits of 100 /150/200 mm dia. Shall be medium duty, class-B type. Galvanizing thickness shall be minimum 75 microns	100 mtrs	
C9.6	Hume pipes for cable at road crossing (200 NB) shall comply to IS:458	100 mtrs	
C9.7	PVC Conduits of 200 mm dia.	100 mtrs	
	Supply of following items		
C9.8	Trefoil clamps for single core cables-25 mm wide 8 SWG Aluminium strips	400 nos	
C9.9	11 kv/6.6 kv danger boards, hand gloves and first aid boxes as per requirement to meet statutory obligations for all the panels erected by the agency	1 set	

C9.10	Rubber mats for HT Switchgear , 1.2m X 2m (thickness shall meet standards specified in I S)	15 nos	
C9.11	Rubber mats for LT Switchgear room, 1.2m X 2m (thickness shall meet standards specified in I S)	30 nos	
C10.0	C&I PACKAGE BHEL HYD		
C10.1	EPABX System panels, 1200 X 800 X 2200 mm	4 nos	
C10.2	EPABX Telephone sets installation in office, house & other buildings	72 nos	
C10.3	Public address system panel (1200X800X2200)	1 no	
C10.4	PA Field call stations	42 Nos.	
C10.5	SWAS ANALYSER comprising of the following: Wet panel rack of size 800 X 800 X 2200, 200 kg Dry panel rack of size 800 X 800 X 2200, 200 kg PH Analyser withg sensor, display unit, cables: 2 nos Conductivity Analyser with sensor , display unit, cables: 2 nos Dissolved oxygen Analyser: 1 no Silica analyser with sensor , display unit, cables: 2 nos Conductivity cells: 2 nos tubings and fittings for the above analysers etc.	1 set	
C10.6	GT Stack Analyser Package comprising of the following: Panel Rack of size 800 x 800 X2200, 200 kg, 2 nos SOX Analyser /NOX Analyser/SPM Analyser/CO Analyser/HC Analyser local control unit/sampling unit, sample tubing upto control panel in SWAS room and fittings etc. Working involve at around 25 mtrs in the GT stack.	1 set	
C10.7	VFD Panel for Hitec Additive Dosing Size: 800 X 800 X 2200 mm; 1500 kg	1 no.	
	PLC Package		
C10.8	Interlock PLC (BOP) Panels, 500 kgs	6 nos	
C10.9	Control Desk, 100 kgs	1 nos	
C10.10	Interlock PLC (BMS) Panels, 500 kgs	4 nos	
	Signal Cables		
C10.11	18P X 1.5 sq.mm	750 mtrs	
C10.12	12P X 1.5 sq.mm individual & overall shielded	46000 mtrs	
C10.13	12P X 16 AWG Cr-Al Extension cable	4000 mtrs	
C10.14	12P X 0.5 sq.mm communication cable	6000 mtrs	
C10.15	8T X 0.5/1.5 cable Individual & overall shielded Triad Cable	15000 mtrs	
C10.16	6P X 1.5 sq.mm individual & overall shielded	25000 mtrs	
C10.17	Signal cable 1P X 1.5 sq.mm	6000 mtrs	
C10.18	1T X 0.5/1.5 cable Individual & overall shielded Triad Cable	4000 mtrs	
C10.19	1P X 0.5 sq.mm communication cable	6000 mtrs	

C10.20	1P X 1.5 sq.mm cable (individual & overall shielded) Intrinsic/Non-Intrinsic safe	20000 mtrs	
C10.21	1P X 16 AWG Cr-Al Extension cable	2000 mtrs	
	Cables for PA system		
C10.22	2P X 1.5 sq.mm	5000 mtrs	
C10.23	4P X 1.5 sq.mm	3000 mtrs	
C10.24	20P X 1.5 sq.mm	3250mtrs	
	Cables for Telephone System		
C10.25	2P X 0.9 sq.mm Non Intrinsic safe	5000 mtrs	
C10.26	4P X 0.9 sq.mm Non Intrinsic safe	5000 mtrs	
C10.27	10P X 0.9 sq.mm Non Intrinsic safe	4000 mtrs	
C10.28	20P X 0.9 sq.mm Non Intrinsic safe	4000 mtrs	
C11.0	Field Instruments		
C11.1	Control valve & ON/OFF Valves (commissioning only)	30 nos	
C11.2	Pressure Gauges	40 nos	
C11.3	Pressure transmitters	55 nos	
C11.4	Temperature guages along with thermowell	50 nos	
C11.5	Differential Pressure transmitters	10 nos	
C11.6	Air filter Regulators	20 nos	
C11.7	RTD/Thermocouple along with Thermowells	50 nos	
C11.8	Mass Flow Meters	4 nos	
C11.9	Radar level transmitters (for HSD/Naphta storage tanks)	6 nos	
C11.10	Junction Boxes, 12/24/40 terminals, explosion proof, weather proof	88 nos	
C11.11	Instrument and Junction Box canopies	200 nos	
C12.0	Skid mounted instruments(removal, callibration , refixing)		
C12.1	Pressure Gauges	40 nos	
C12.2	level transmitters	6 nos	
C12.3	level switches	4 nos	
C12.4	DP guages	15 nos	
C12.5	DP Transmitters	15 nos	
C12.6	temerature guages	15 nos	
C12.7	Pressure transmitters	15 nos	
C12.8	Pressure/DP switches	5 nos	
C13.0	Impulse pipes		
C13.1	SS Pipe 33.4 x 3.4 mm	100 mtrs	
C13.2	SS Pipe 12.7 x 2.1 mm	400 mtrs	
C13.3	SS Pipe 21.3 x 3.7 mm	400 mtrs	

C13.4	SS Tube 6 X 1 mm	100 mtrs	
C13.5	AS Pipe 21.3 X 4.74 mm	200 mtrs	
C13.6	CS Pipe O.D 21.3	200 mtrs	
C14.0	GT Instruments (Removal(if applicable), callibration, checking and erection)		
C14.1	Solenoid for inlet air system	75 nos	
C14.2	Temperature Switches	13 nos	
C14.3	Vibration sensors (seismic)	11 nos	
C14.4	Shaft Vibration sensors	16 nos	
C14.5	Temperature rise type fire detectors	9 nos	
C14.6	Pressure switches	35 nos	
C14.7	Limit Switches	12 nos	
C14.8	Magnetic pickups	12 nos	
C14.9	Pressre transmitters	11 nos	
C14.10	Pressure/ DP switches fo DD & GD	4 nos	
C14.11	DP Transmitters	3 nos	
C14.12	LVDT's	2 nos	
C14.13	Themometers	5 nos	
C14.14	Pressure Guages	25 nos	
C14.15	DP Guages	15 nos	
C14.16	Thermocouples (including thermowell as applicable)	45 nos	
C14.17	Hazardous gas sensor (Naphta)	9 nos	
C14.18	Fire detectors (RTDs for generator)	12 nos	
C14.19	Flame Scanners	2 nos	
C14.20	Ignitor with Excitor Probes	2 nos	
C15.0	CO2 Fire Detection System		
C15.1	Manual call points	6 nos	
C15.2	Hooters	4 nos	
C15.3	Pressure switches	6 nos	
C15.4	Solenoid valves	6 nos	
C15.5	Junction boxes	10 nos	
C16.0	Miscellaneous Items		
C16.1	2" GI Pipe for transmitter and JB mounting & Support set up	200 m	
C16.2	Explosion proof power/control junction boxes (for DD & GD), 50 kg each.	4 Nos	
C16.3	Explosion proof PB junction boxes (for DD & GD)	2 nos	
C16.4	JB's for air inlet system	6 nos	
C16.5	1", 0.5" conduits for wiring solenoids	50 mtrs	
C16.6	Wiring in rigid GI conduit for solenoid valves to JB and local panelwith 1 CX 2.5 sq.mm wire.	200 mtrs	

D2.2	<p>CO + SO₂ + NO_x + HC Analyser comprising of the following: 1 No. local analyser and display panel panel of size 800 X 800 X 2200 mm, with sample handling system. Ring header with electrical heating, heater to be mounted at site, header to be mounted at 30 mtrs level of HRSG Stack, control panel to be mounted at suitable location on platform or floor. Aprx. 50 mtrs long impulse pipe with electrical tracing consisting of 50 mtrs heat tracing tapes, aluminium foil covering, ceramic wool insulation, aluminium cladding. Purge Instrument Air Line of approx. length 20 mtrs Sampling cylinders, 20 mtrs long sampling lines Electrical & power cabling between these equipments, earthing of panels and water resistant painting for impulse pipes & header. Approx weight: 500 kg The scope of work includes erection, integration of the system and commissioning</p>	1 set	
D2.3	<p>SWAS ANALYSER comprising of the following: Wet panel rack of size 2700 X 600 X 2200 mm Dry panel rack of size 600 X 500 X 2200 mm PH Analyser with sensor, Display Unit, Cables etc: 3 Nos Conductivity Analyser with sensor, Display Unit, Cables etc: 3 nos Silica Analyser Sensor : 1 No Tubings and fittings for above analysers etc. Approx,. weight : 4000 kg</p>	1 set	
D2.4	<p>Electronic Water Level indicator EWLI Comprising of the following: 1 No. 10 Port pressure vessel with loose supplied electrodes 1 No. Local Display unit, of size 400 (W) X 425 (H) mm 1 No. Remote Display unit of approx. size 100 X 90 X 230 mm interconnecting cables between local panel and electrodes, etc</p>	2 set	
D3.0	Erection Hardware		
D3.1	Push Button Boxes, 10 kg each	4 Nos	
D3.2	Junction Boxes, 19 kg each	16 Nos	
D3.3	1/4" OD Copper tube	100 mtrs	
	Earthing materials		
D3.4	25 x3.15mm GI Flat	500 mtrs	
D3.5	GI wires-8 SWG	250 mtrs	
D4.0	CABLES		
D4.1	3 C X 2.5 sq. mm, Copper	10000 mtrs	
D4.2	3C X 6 SQ.MM	5300 mtrs	

D4.3	3C X 10 SQ.MM	1000 mtrs	
D4.4	3C X 16 SQ.MM	300 mtrs	
D4.5	3C X 50 SQ.MM	300 mtrs	
D4.6	3C X 120 SQ.MM	300 mtrs	
D4.7	5 C X 1.5 sq.mm	500 mtrs	
D4.8	10 C X 2.5 sq.mm	1500 mtrs	
D4.9	2 Pair, 1.5 sq.mm Screened Inst Cable	4400 mtrs	
D4.10	2 Pair, 20 AWG KX Screened Compensating Cable	1500 mtrs	
D4.11	1 PairX1.5 sq mm2 screend cable	7000 mtrs	
D4.12	12Pair,0.5 mm2 screened cable	5000 mtrs	
D5.0	CABLE TRAYS		
D5.1	Ladder Type tray, 100 mm wide	150 mtrs	
D5.2	Ladder Type tray, 450 mm wide	25 mtrs	
D5.3	Ladder Type tray, 600 mm wide	50 mtrs	
D5.4	Perforated Type tray, 100 mm wide	50 mtrs	
D5.5	Perforated Type tray, 450 mm wide	25 mtrs	
D6.0	STRUCTURAL STEELS		
D6.1	Angle 50X50X6	0.5 MT	
D6.2	Channel 100X50	1.0 MT	
E1.0	BHEL EDN C&I PACKAGE		
E1.1	MARK-VI TURBINE CONTROL PANEL 2257 X 910 X 2400, 1100 kg Installation of 3 Nos <I STATION> CPU, 3 Nos MONITOR, 3 nos PRINTER,LINE DRIVER ,one no. Network switch to be mounted in enclosure,Interconnecting ethernet Cabling (approximately 250 mtrs)(including termination and checking), Installation of furniture etc. The scope of work includes integration of the system and commissioning.	1 set	
E1.2	Digital Automatic Voltage Regulator (DAVR) Panel, 1150 X 1200 X 2295 mm, 1200 kg	1 set	
E1.3	DCS SINGLE CUBICLE maxDNA PANELS 800x750x2185mm, wt-400kgs CTE01,CTE02,CTE03,CTE04	4 Set	
E1.4	SUITE OF TWO CUBICLE max DNA panels 800X1500X2185mm, WT-800KGS CRE01-02,CRE03-04,CRE05-06,CVP01-02,CVP03-04	5 Set	
E1.5	SCADA ECS PANELS 800X1500X2185mm,wt-800kgs SUIT OF TWO CUBICLE max DNA panels CAR11-12,CAR13-14,CAR15-16,CAR18-19,CAR20-21	5 Set	

E1.6	SCADA ECS PANELS 800X750X2185mm, wt-400kgs SINGLE CUBICLE max DNA panels CAR17,CAR22 ,CAR23 &CAR30	4 Set	
E1.7	COMPUTER STATIONS ALONG WITH ACCESSORIES (PRINTERS,UPS and Furnitures ETC..)	16 Set	
E1.8	OPERATOR CONTROL DESK	16 Nos	
E1.9	ETHERNET CABLE	500 mtrs	
E1.10	LAYING OF FIBRE OPTIC CABLE THROUGH HDPE CONDUIT	500 mtrs	
F1.0	DG Set-ISG		
F.1.1	DG set- Erection of electrical panel(AMF) approximate dimension 1000 X 1000 X 2200 mm, cabling and commissioning assistance.	1 No.	
	GENERAL		
G.1.0	Commissioning of the following equipment erected by others		
G.1.1	Meggering of Generator Bushing ,Generator, including of commissioning of generator	1 set	
G.1.2	Electric actuators	80 Nos	
G.1.3	Meggering and dry out of LT drives	50 Nos	
G.1.4	Control Valves	30 Nos	
G.1.5	Hoists	2 nos	

PART –I CHAPTER -X

ELECTRICAL PACKAGE/C&I/ILLUMINATION PACKAGES

GENERAL

The scope of the work will comprise of but not limited to the following:

- 1.10.1 Identification of equipments at storage yard, technical assistance for checking and making the shortage/damage reports, taking delivery from storage yard/ stores and calibration, erection, aligning, fastening, supporting, cleaning, checking, testing, commissioning, troubleshooting and carrying out statutory tests as required, trial operation, up to the time of completion of commissioning activities and commercial operation of the unit and handing over to customer or till completion of contract period whichever is earlier, along with the supply of all consumables, tools and tackles and testing instruments.
- 1.10.2 It is not the intent to specify herein all details of material. Any item related to this work not covered, but necessary to complete the system will be deemed to have been included in the scope of the work.
- 1.10.3 All the work shall be carried out as per instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the contractor.
- 1.10.4 Contractor shall erect all items/materials etc. as per sequence prescribed by BHEL at site. BHEL engineer depending upon the availability of materials/work fronts etc will decide the sequence of erection/commissioning methodology. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of erection/commissioning adopted in erection/commissioning of similar job or for any reasons whatsoever.
- 1.10.5 Site testing wherever required shall be carried out for all items/materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.
- 1.10.6 The contractor shall co-ordinate and provide assistance for satisfactory testing, pre-commissioning, commissioning and trial run of the connected equipment under overall guidance of BHEL and shall locate any cause of malfunction and rectify the same for proper operation. Testing shall also include any additional tests, which the Engineer feels necessary because of site conditions and also to meet system specification.

- 1.10.7 During the course of erection, testing and commissioning Electrical/ C&I work certain rework / modification / rectification / repairs / fabrication etc. may be necessary on account of feedback from other power stations or units already commissioned and/ or units under erection and commissioning and also on account of design changes and manufacturing incompatibilities and site operation / maintenance requirements. Contractor shall carryout such rework / modification / rectification / fabrication / repairs etc, promptly and expeditiously and the same shall be deemed to be part of the scope of work.
- 1.10.8 The work shall be executed under the usual conditions without affecting power plant construction and in conjunction with other operations and contracting agencies at site. The contractor and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.
- 1.10.9 All necessary certificates and licenses required to carry out this work are to be arranged by the contractor expeditiously at his cost.
- 1.10.10 The contractor shall take delivery of item, materials, from the storage yard / stores/ sheds of BHEL / customer which are within plant premises. He shall also make arrangements for, safe custody, watch and ward of equipment after it has been handed over to him till they are fully erected, tested and commissioned till the contract period. The contractor shall note that items/materials shall be transported to erection site / assembly yard etc. by the prescribed route without disturbing and causing damage to other works in the most professional manner. All items, Hardware, etc. shall be stored in appropriate manner as per BHEL's instructions.
- 1.10.11 The contractor shall take delivery of items/materials, and consumables from the stores/ storage area / sheds of BHEL / customer after getting approval of engineer / customer in the prescribed indent forms of BHEL / customer.
- 1.10.12 After completing all the works, contractor shall hand over all remaining extra materials with proper identification tags in packed condition to BHEL stores. In case of any use over actual design requirements, BHEL reserves the right to recover the cost of material used in excess or misused. Decision of BHEL engineer in this regard will be final and binding on the contractor.
- 1.10.13 Contractor shall, transport all materials to site and unload at site / working area, or pre-assembly yard for inspection and checking. All material handling equipment required shall be arranged by the contractor.

- 1.10.14 Contractor shall retain all T&P/Testing instrument/Material handling instrument etc at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.
- 1.10.15 Contractor shall remove all scrap materials periodically generated from his working area in and around power station and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect. All the package materials, including special transporting frames, etc. shall be returned to the BHEL stores / customer's stores by the contractor.
- 1.10.16 If any item or equipment not covered but requires being erected/commissioned, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.
- 1.10.17 The contractor at his cost shall arrange necessary security measures for adequate protection of his machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor's construction equipment and materials. The contractor may consult the Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.
- 1.10.18 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.
- 1.10.19 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances.
- 1.10.20 Scope of work covered under this specification requires quality workmanship, engineering and construction management. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments, calibrating equipment etc. in his possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled personnel. The manpower deployed by contractor shall match with above scope of works.

- 1.10.21 All the surplus, damaged, unused materials, package materials, containers, special transporting frames, etc. shall be returned to the BHEL stores / customer's stores by the contractor.
- 1.10.22 Any wrong erection shall be removed and re-erected promptly to comply with the design requirements to the satisfaction of Site Engineer.
- 1.10.23 BHEL will provide vendor's technical support for commissioning of various proprietary type special instruments/systems like Analysers, Vibration Monitoring System, Battery/ Battery Charger, Microprocessor based relays, Flame Scanners etc. The contractor shall carry out the works as per instructions of BHEL/ Vendor Engineer.
- 1.10.24 The scope of specification covers the installation, testing and commissioning of the instrument, hardware along with accessories as detailed in Bill of Materials.

Note:

1. Bill of Materials (BOM) contains detailed specification of various instruments and items, system-wise and BHEL Unit- wise along with relevant clause for scope of works.
2. The Rate Schedule contains the consolidated list of BOM with brief description of items.
3. Rates are to be filled only in the Rate Schedule.
4. Before filling the Rates in the rate schedule, the bidder shall go through the detailed specification of all items of BOM as well as Scope of Work as specified in relevant Clause of this document.
5. The quantity indicated in the BOM/ Rate Schedule is tentative only and is liable for variation. Payment will be made as per actual quantum of job executed at the unit rate accepted by BHEL.

PART –I CHAPTER -XI

ELECTRICAL PACKAGE

1.11.0 SCOPE OF WORK FOR ELECTRICAL PACKAGE IN GENERAL

- a. Erection and commissioning of Generator Transformers, Station Distribution Transformer, Station Emergency Transformer
- b. Erection and commissioning of HT/ LT Busducts,
- c. Erection and commissioning of HT/ LT Switchboards, Miscellaneous Distribution boards and Panels, Battery and Battery charger panels, GTG Control/ relay/ excitation panels.
- d. Installation of NGRs
- e. Installation of cabling system.
- f. Installation of cable termination and straight through joints (as applicable) for HT/LT power cables, control cables.
- g. Installation of GI materials for clamping the multi core LT power and control cables.
- h. Installation of trefoil cable clamps for clamping single core HT power cables.
- i. Installation of GI pipe/conduits in various sizes, and RCC Hume pipes and fittings for cable installation, wherever required.
- j. Fabrication and installation of steel supports, wherever required.
- k. Supply (if applicable) & installation of explosion proof double compression cable glands, cable lugs, ferrules, cable identification tags, cable dressing materials etc.
- l. Supply of Hardware like clamps, bolts, nuts, brackets, anchor fasteners etc.
- m. Installation of flexible GI conduits.
- n. Supply of adequate quantity of touch up paint and paints as required for items covered in scope of works.
- o. Supply as well as installation of material for sealing and making vermin/ dust proof unused openings, if any, in panels/ JB's
- p. Installation of Danger Board, First aid box
- q. Installation of canopy for outdoor pushbutton stations/motors/panels/ instruments
- r. Installation of rubber/ PVC floor mats for HT/ LT panels.
- s. Supply of all consumables and hardwares required for installation.
- t. Arranging all scaffolding and platforms for erection of cables, panels etc.

1.11.1 SCOPE OF WORK FOR TRANSFORMER

- 1.11.1.1 Receipt of all Transformer and associated loose supplied accessories including oil drums from store/yard, inspection, transporting the above to the respective erection location up to plinth, storage, maintenance of N₂ gas pressure in transformer tank, erection of Transformer and all the accessories, cabling from transformer accessories to marshalling box & OLTC panel, oil filling, testing of oil, dry out, pre-commissioning test, commissioning of equipment and final painting and handing over.
- 1.11.1.2 Contractor shall load the transformer from storage yard, transport and unload the transformers on rails, turn the wheels/rollers if necessary, roll the transformers to their respective locations and positioned on the foundation or by any other means of shifting and positioning transformer on the foundation. The necessary sleepers, winches, jacks etc. required for this operation will be arranged by the contractor at his cost. The components of the transformers will be sent to site in several packages which shall be assembled and erected.
- 1.11.1.3 Samples of each and every drum of transformer oil shall be tested and pre-treated to achieve the desired value before filling in to the transformer tank. The entire arrangement for testing the oil sample, filtering whenever required to achieve the desired PPM, BDV within the shortest time shall be made by the contractor in consultation with Engineer In Charge at site at the cost of the contractor. All the test equipment for testing specific gravity, PPM, BDV of the oil including testing equipment required for the Tan-Delta Test for transformer winding and HV Bushing shall be arranged by the contractor.
- 1.11.1.4 Checking of protective system such as Buchholz relay explosion vent, oil and winding temperature detectors etc. shall be checked under the guidance and supervision of BHEL Engineer.
- 1.11.1.5 Contractor shall carry out all tests with their own testing equipments and testing team.
- 1.11.1.6 All other T&P, like material handling equipment like crane, Trailer, High Vac filter machines with adequate capacity, vacuum pumps and 5 kV motorized megger and oil tank of suitable capacity shall be arranged by the contractor at his cost. Operator, fuel and other consumables shall also be arranged by the contractor. The transformers may have to be suitably lagged/covered during the drying out operation by the contractor at no extra cost.
- 1.11.1.7 The contractor will engage his men on three-shift operation during drying out the transformers
- 1.11.1.8 The auxiliaries components of the above transformers are to be cleaned and checked before the assembly as instructed by BHEL Engineer.

- 1.11.1.9 Test value of dielectric strength/PPM, specific gravity and Tan-Delta test shall be as per recommended value of BHEL. If the test results are not satisfactory and if the customer desires to carry out the tests through some other agency, the same shall be carried out at contractor's cost.
- 1.11.1.10 The scope of erection work **includes final painting**, minor civil work such as chipping and grouting of the support structure as well as for the support of the transformer. The scope of final painting involves supply of paints, thinner and other consumables at the cost of the contractor. No separate rate shall be paid for painting. Painting shall be as per details given in the painting clause.
- 1.11.1.11 During the oil circulation of the transformer, the contractor has to employ sufficient number of personnel who will take care of the operation of the filter machine as well as safety of the transformer.
- 1.11.1.12 Calibration of testing equipment: All testing equipment (IMTE) shall be calibrated before putting into service at site. A copy of calibration certificate to be this effect shall be furnished to BHEL-Engineer for his verification and approval.
- 1.11.1.13 The contractor shall prepare all log sheets, test certificates, protocols etc. as per field quality plan, get it signed by concerned BHEL/customer Engineer and submit to the concerned BHEL Engineer
- 1.11.1.14 Preservative gas like N₂ shall be supplied by BHEL free of cost to maintain the N₂ pressure during preservation.

Note: Refer general technical requirements for erection, testing and commissioning

1.11.2 BUSDUCTS:

1.11.2.0 SEGREGATED PHASE BUSDUCTS

1.11.2.0.1 SP BUS DUCT FROM GENERATOR TO CABLE BOX

The segregated phase busducts is connected to the cable panel and generator. The cable panel is connected to the 11 kV side of transformer by HT cables. The bus consists of rectangular conductor made of aluminium alloy supported on post insulators. Flexible connections and expansions joints are provided at terminal and intermediate points to alleviate stresses due to expansion and to arrest vibration. All the CTs will be mounted inside the busducts.

Each set of segregated phase busduct shall be supplied complete with AL alloy enclosure and conductor, Al alloy barrier, single porcelain bus support insulator arrangement, rubber bellows, inspection windows etc. All bolted joints shall have high tensile steel hardware which shall be cadmium plated/ zinc plated and passivated. All conductor bolted joints shall be silver plated.

Tap-off busducts connect the potential transformer, surge protection equipment to the main bus. The protection equipment and potential transformers shall be housed in metal clad cubicles.

A sheet steel totally enclosed cubicle is provided to connect the Generator neutral point. The neutral side cubicle houses neutral grounding transformer & resistors.

The following equipment are covered in the scope of erection/commissioning of Segregated Phase Busducts:

A. MAIN BUSDUCT (PHASE SIDE):

Each set of 11 kV, 2000 A, segregated phase bus ducts for GTG connecting the generator line side terminals to the cable panel shall be complete with AL alloy enclosure and conductor with single epoxy bus support insulator arrangement, epoxy seal off bushing, make up pieces, inspection windows, copper flexibles etc. All bolted joint hardware shall be of high tensile steel Cadmium plated or Zinc plated and passivated. All conductor bolted joints shall be silver plated.

B. MAIN BUSDUCT (NEUTRAL SIDE):

11 KV busduct from the neutral side adopter box to the star point shall generally be in line with Main bus duct.

C. NG CUBICLE/NEUTRAL SIDE CUBICLE:

Each NG Cubicle shall be fabricated out of 3 mm thick steel sheet complete with illuminating lamps, space heater, busbars, mounting insulators, marshalling box, etc. Each set shall house the following:

- i. Dry type epoxy cast NG transformer
- ii. NG Resistor

D. TAP OFF BUSDUCT (PTSP Cubicle):

The tap off 11 kV busduct connecting the main busduct to PTSP cubicle shall generally be in line with Main bus duct.

E. PT SP CUBICLE:

PT&SP Cubicle shall be of draw out type fabricated out of 3 mm thick steel sheet, complete with PTs, Surge Protection equipment, illuminating lamps, space heater, busbars, mounting insulators, marshalling box, etc. The cubicle shall be self-supporting type.

F. BUSDUCT SUPPORTING STRUCTURE:

Each set of busduct supporting structure shall be fabricated from standard steel sections welded/bolted and hot dip galvanized. All structure hardware shall be HTS hot dipped/electro-galvanized.

G. SHORTING BARS:

One set of shorting bar common for both the sets shall be supplied for generator dryout.

1.11.2.0.2 SP BUSDUCT (GEN TRANSFORMER TO 6.6 KV SWGR):

Each set of 6.6 kV, 3150 A, segregated phase bus ducts connecting the generator Transformer to the 6.6 KV Switchgear panel shall be complete with AL alloy enclosure and conductor with single epoxy bus support insulator arrangement, epoxy seal off bushing, make up pieces, inspection windows, copper flexibles etc. All bolted joint hardware shall be of high tensile steel Cadmium plated or Zinc plated and passivated. All conductor bolted joints shall be silver plated.

1.11.2.1.0 SCOPE OF WORKS FOR ERECTION & COMMISSIONING OF SEGREGATED PHASE BUSDUCTS

The general scope of works for Segregated Phase Bus duct is as below.

- 1.11.2.1 Receipt from BHEL stores/yards, unloading all the busduct materials and accessories and equipment at the area where the busducts are to be erected, inspection, installation of all the materials as indicated in the BOM and relevant drawings, testing and commissioning of total busduct items, painting and handing over, as detailed below.
- 1.11.2.2 Transport of Busducts and associated items and accessories from BHEL Stores to erection site.
- 1.11.2.3 Cleaning of enclosure and conductors, insulators and other panels before assembly/ erection.
- 1.11.2.4 Placement of embedments and erection and alignment of steel support structures.
- 1.11.2.5 Assembly and checking of busduct at ground level if necessary.
- 1.11.2.6 Minor civil work such as chipping and drilling holes on concrete if necessary and grouting of busduct support structures including supply of materials required for civil works.
- 1.11.2.7 If any modification is required in the support structures due to site conditions, the same shall be carried out without any extra cost. Pockets will be provided during casting in which anchor bolts will be grouted for supporting the structures.
- 1.11.2.8 Extension of embedment if required and erection of required supports structures as detailed in the drawing.
- 1.11.2.9 Tightening of all bolts in the joints and flanges by torque wrench to the approved pressure (Anti oxidation compound to be used for joints shall be arranged by contractor)

- 1.11.2.10 Conducting air-tightness test after erection to meet the BHEL Standards. Rectification of leakage, if any without any extra charges. For air tightness test, contractor shall arrange necessary pipe, PVC, hoses, fitting, valve, pressure regulator, rotameter etc. at their cost. Contractors shall tap the air from nearest Instruments air tapping point available at site. Detailed test procedure for the above shall be furnished later on at site.
- 1.11.2.11 Conducting high voltage test and other tests as detailed in Section VII as per instruction of BHEL engineer after cleaning inside as well as outside of the busduct & arranging all testing equipment required.
- 1.11.2.12 Fixing of current transformers in busducts including wiring from CT terminal to local junction box, taking through rigid/flexible conduit pipe.
- 1.11.2.13 **Carrying out final painting as per the standard color codes recommended by BHEL for all the items covered in the scope including supply of paints, thinner and other consumables etc. as required as part of erection. (For more details, refer scope of painting).**
- 1.11.2.14 Erection and commissioning of NG cubicle with all its accessories if supplied as loose.
- 1.11.2.15 Fixing of neutral side flexible connections to generator and positioning of neutral CTs after testing.
- 1.11.2.16 Assembly, erection and commissioning of PTSP cubicles with its equipment such as lightning arrestors, voltage transformers, fuses, etc.
- 1.11.2.17 Erection and alignment of Tap off busducts for PTSP Cubicle & NG Cubicle, cable box.
- 1.11.2.18 Grouting of busduct support structures.
- 1.11.2.19 Running of earth flats and earthing of busducts, cubicles, Marshalling boxes and structures, as detailed in the relevant bus duct drawings.
- 1.11.2.20 Carrying out minor repair, rectification of enclosures/ conductors wherever required.
- 1.11.2.21 Arranging all T&P material handling equipment required for erection.
- 1.11.2.22 Arranging all Testing instruments, which have been calibrated.
- 1.11.2.23 Furnishing copy of the calibration certificate to the concerned BHEL Engineer for verification and approval.
- 1.11.2.24 Submitting necessary log sheets, protocols, test certificate as per Field Quality Plan and getting them signed by BHEL/Customer Engineers, and submitting the same to BHEL.

1.11.2.25 Maintaining the equipment after commissioning till taken over by Customer

NOTES

1. Holes on the generator terminal box flange may not be adequate and any holes if required shall be drilled at site to facilitate matching of busduct cover flange with generator flange easily at site.
2. Operators and necessary helpers, and Diesel for operating crane shall be arranged by the Contractor.
3. Any minor modification required in the busduct conductor/ enclosure for matching with generator and cable box shall be carried out without additional cost.
4. Contractor shall carry out all tests with their own testing equipments and testing team.
5. Refer Section VII for general technical requirements for erection, testing and commissioning.

1.11.3 SCOPE OF WORK FOR LT BUSDUCTS

- a. The scope of work in general will be as per the scope of HT SP bus ducts described above and as applicable for LT bus ducts, testing and commissioning as per vendor recommendation shall be carried out. Contractor shall arrange all the necessary T&P's for the work.
- b. LT Bus ducts shall be of Non-segregated Phase Type, rectangular shape with rubber bellows made out of Aluminium enclosure with Aluminium Bus Bar. The Aluminium busbars shall be supported with insulators. LT Busducts are used for connecting LT Transformers and PCC / MCC. Necessary busduct supporting materials like GI or MS angle/channels shall be supplied along with bus ducts. The support materials supplied may be either prefabricated or of standard length and the same shall be fabricated and installed as per site requirements.
- c. Minor civil works like chipping, grouting and painting of supports shall also be part of scope of works.
- d. If there is any mismatch or inadequacy of the holes on the bus duct flange, the same shall be drilled at site to facilitate matching of bus duct flange with Transformer or PCC/MCC flanges.

1.11.3 HT/ LT SWITCHGEARS, POWER DISTRIBUTION BOARDS, AVR AND OTHER CONTROL PANELS.

1.11.3.1 6.6 KV HT SWITCHGEAR PANELS:

General construction and operation features of HT Switchgear:

The HT switchgears shall be of Type VM4 metal clad switchgear of horizontal draw out pattern, suitable for easy extension of switchboard on both directions for systems up to 4 KV. The design incorporates single busbar system and a set of interlocks for safety of operations and is fully compartmentalized. A panel consists of a fixed portion (and a moving portion) of modular construction having three high voltage chambers namely breaker chamber, bus bar chamber and CT chamber. Instrument panel is a separate low voltage chamber and shall be supplied with different type of protection relays, Instruments like Meters, Transducers, etc. Moving portion comprises of wheel-mounted truck fitted with an operating mechanism, vacuum interrupters & isolating contacts. Generator relay and control panels shall be supplied with different type of protection relays, Instruments like Meters, Transducers, etc and these panels shall be mounted at unit control room.

Motor operated spring closing mechanism keeps the springs charged after every closing operation making it ready for next enclosure. Springs can also be charged manually in case of failure of auxiliary power to the spring charging motor.

1.11.3.2 Scope of work of HT Switchgear panels:

- a. The scope of work shall include receipt of panels, accessories & spares including rubber mats from site stores/yard, inspection, handling of accessories between stores and erection location, storage, erection of accessories, fabrication and installation of base frames wherever required, testing commissioning, touch up painting and maintenance up to handing over.
- b. The base frames shall normally be supplied along with the boards. These shall be aligned, leveled and grouted in position as per approved drawings. Wherever the base channels are not available, the same shall be fabricated, erected and painted at site. The material for this shall be supplied by BHEL. Base channels shall be grouted on the opening of the floor. If grouting bolts are required for the panel, the same shall be supplied within the quoted rate. All minor concrete chipping and finishing works are deemed to be included in the scope of the job including. If base frame is to be fabricated, separate rate shall be paid on Tonnage basis.

- c. For the panels to be mounted on the trenches, channel supports shall be provided across the cable trenches over which the base frames of the panels shall be mounted. Support structures if required shall be fabricated and separate rate on Tonnage basis shall be paid for the fabrication.
- d. Panels shall be delivered in different shipping sections. Necessary interconnection of busbar, inter panel wiring, etc. shall be carried out as part of panel erection.
- e. Generally the panels shall be supplied with complete Relays/ Instruments and other Components mounted and wired. However, any minor modifications like dismantling of the existing Relays/ Instruments/Components and mounting of new Relays/ instruments /components and rewiring to suit operating conditions, shall be carried out without any extra cost. However, if any major wiring modification is involved inside the panel, the same shall be carried out at extra works basis. Similarly if any Relays/ Instruments /component supplied as loose for safety transit, same shall be mounted and wired as per site requirement at free of cost as part of scope of the job. However, if the loose supplied Relays/ Instruments/Components are more than 10% of the total quantity, the same shall be carried out at extra works basis. Decision of site engineer shall be final regarding such extra works.
- f. The commissioning of Switchgear shall also involve the trial runs and commissioning of all connected equipment like motors and Service Transformer. The contractor shall have to keep his people round the clock, if necessary during the trial runs and promptly take action for any repair, checks and rectification etc. required in the equipment erected by him. (Separate rate shall be paid for commissioning of associated electrical drives as per BOM).
- g. The contractor shall do touch up painting of switchgear panels wherever necessary. This includes supply of paint also.
- h. All T&P, Material handling equipment including cranes, Relay Testing/ HV Testing/ Calibration Instruments, primary/secondary injection kits, CRO, frequency counter etc. shall be arranged by the contractor.
- i. Subject to availability, BHEL shall provide EOT cranes for the purpose of shifting the panels with in the PH building on sharing basis at free of cost. However, the contractor shall arrange operator and other T&P.
- j. The contractor shall calibrate and commission all switchgear/panel mounted instruments, protection relays, transducers, Recorders, Indicators, energy meters etc.

- k. **BHEL shall provide vendors' supports for commissioning of proprietary type of microprocessor based instruments and protection relays which requires software loading and programmer etc. However overall responsibility lies with the contractor and the contractor shall provide all support like manpower, standard T&P, Instruments etc for calibration and commissioning of above proprietary type instruments.**
- l. **The contractor shall carry out testing and commissioning works with their own testing equipments and testing teams under the supervision of BHEL/Customer Engineers.**
- m. All testing Instruments/ Equipment deployed to site shall be calibrated before putting it into service. A copy of calibration certificate shall be submitted to BHEL Engineer for his verification and approval.
- n. Switchboards incomer bus may be cables/ connected to SP bus ducts through adapter box. The contractor shall co-ordinate for proper busbar connection. Any modification required in the bus conductor for matching SP busduct busbar shall be carried out without extra cost.
- o. The contractor shall co-ordinate with cable jointer and other LT cable-laying agency for proper cable termination and also during HP testing of cable.
- p. Contractor shall prepare all erection/ commissioning log sheets, protocols/test certificates as per field quality plan, get it signed by the concerned BHEL/ CUSTOMER Engineer and submit the same to BHEL Engineer as per his instruction.
- q. The charged and commissioned equipment shall be maintained by the contractor till the same is taken over by Customer or up to the contract period.
- r. Any items like lamps, lens, fuse/relays/instruments missed/ damaged from the custody of the contractor shall be replaced by the contractor at his cost. However, in case the damage is not due to reasons attributable to the contractor, BHEL may arrange for free replacement. The decision of BHEL Engineer in charge in this regard will be final and binding.
- s. The contractor shall arrange watch and ward for the equipment under his custody and erected in location against theft and damage by other agencies working on the same area.
- t. If any removal/ Re-fixing of contactors/relays becomes necessary for the completion of the system, the same shall be done by the contractor at free of cost.
- u. Rubber/ PVC mats for switchgear shall be supplied by BHEL, and these shall be laid, wherever required as part of panel erection.

- v. Contractor shall close unused opening at the panel bottom plate with suitable material in consultation with Site Engineer at no extra cost as part of panel erection.
- w. Scope of work shall also cover drilling of bottom gland plates for cable entry as required.
- x. Dimensions & weights indicated in the BOQ against various panels are approximate only. There may be variations in the weight and dimensions. Variations in depth, height or weight of the panel shall not be considered for payment.
- y. Any variation in length within $\pm 10\%$ shall not be considered for payment and if any variation in length beyond $\pm 10\%$ as compared to actual length indicated in the BOQ, payment shall be considered proportional to the length of the panel only.

1.11.3.3.SCOPE OF AVR/ GENERATOR CONTROL/ RELAY PANELS/ VFD AND OTHER ELECTRICAL CONTROL PANELS

- a. The panels shall be supplied with different type of protection relays, Instruments like Meters, Transducers, etc and these panels shall be installed in unit control room.
- b. The scope of work will be generally in line with Electrical Switchgear panels as detailed under above clause.
- c. The scope of work shall also include Testing, Calibration and adjustment of relays, electronic cards and instruments, transducers mounted on the panels.
- d. If panels are supplied with monitor, printers, furniture, controller etc. or any loose items or equipments, the erection of above shall be part of respective panel.
- e. Normally the panels shall be supplied with instruments / modules mounted and wired. No separate payment shall be made for commissioning of any instrument/ cards/ components. If dismantling of the above such instruments and rewiring are needed at site, the same shall be carried out at no extra cost. If any instruments/ cards/ components supplied as loose items for safe transit, the same shall be mounted and wired at no extra cost.

1.11.3.4 LT SWITCHBOARD, AC/DC DB

LT MCCs are simple module type with isolators and fuses. However, some of the MCCs are Double Front draw out type consisting of circuit breakers unit, contactors/starter fuse switch units, MCB etc. arranged in multi-tier construction. These MCCs and AC DBs are mainly supplied to cater the requirement of drives, valves, etc. All the LT Switchgear, AC DB shall be located in Switchgear room of Power House.

1.11.3.5 SCOPE OF WORK FOR LT SWITCHBOARD AND AC/ DC DB

1. Scope of work for LT Switchboard and AC/DC DB

The scope of works shall be similar to HT switchgear. However the following point specific to LT switchgears are to be considered.

- a. The commissioning of LT Switchgear shall also involve the trial runs and commissioning of all connected equipment like servomotors and drives etc. The contractor will have to keep his people round the clock, if necessary during the trial runs and promptly take action for any repair, checks and rectification etc. required in the equipment erected by him. (Separate rate shall be paid for commissioning of associated electrical drives as per BOM).
 - b. MCC incomer bus shall be connected to PCC of customer. The contractor shall co-ordinate for proper connection at PCC.
 - c. Dimensions & weights indicated in the BOQ against various panels are approximate only. There may be variations in the weight and dimensions. Variations in depth, height or weight of the panel shall not be considered for payment.
 - d. Any variation in length within $\pm 20\%$ shall not be considered for payment.
 - e. If the panels supplied at site have any variation in length beyond $\pm 20\%$ as compared to actual length indicated in the BOQ, payment shall be considered proportional to the length of the panel only.
 - f. Erection of Resistance box of DC drives, if applicable, shall be part of DC starter panel erection.
2. Scope of work shall also covers transportation of earthing trucks and trolleys that are supplied along with switchgear to switchgear room and arrange for handing over to Customer after commissioning of the systems

1.11.3.6 BATTERY AND BATTERY CHARGER

The batteries are of heavy duty type capable of providing normal and emergency DC loads. The cells will be mounted on insulators carried on suitable wooden stands. The chargers are fully thyristorised and shall comprise of Silicon Controlled Rectifier with transformer, switchgear and automatic regulation. The float and boost chargers will be housed in separate cubicles and mounted side by side. Tentative details are given in the BOM.

1.11.3.7 SCOPE OF WORK FOR BATTERY

- a. Collecting the batteries and all the accessories from stores and assembling on the wooden racks and fixing the all loose items supplied with the battery charger as per drawings and making any minor modifications or changes in wiring, if required, without any extra cost.

- b. Filling the shells with loose supplied alkali/acid- if applicable.
- c. Arranging for suitable load for charging and discharging during charging and discharging cycles.
- d. Arranging manpower in shift during charging and discharging cycles which is to be carried out round the clock as per the code of practice and conducting other routine test as per the IS under the supervision of the BHEL engineer..
- e. Arranging necessary tools, T&P, Testing & calibration instruments required for erection and commissioning of the above electrical equipment/panel.

1.11.3.8SCOPE OF WORK FOR BATTERY CHARGER

The scope of work will be in line with Scope of work for Electrical Control Panels, as detailed above.

PART –I CHAPTER -XII

1.12.0 C&I PACKAGE

1.12.1 SCOPE OF WORK FOR C&I PACKAGE IN GENERAL

The C&I works shall be covered for the total plant, which consists of Gas turbine, Generator, HRSG and other auxiliaries.

The Scope of C&I work covered in the above packages shall be as follows:

- u. Erection and commissioning of All Types of Field Instruments like Temperature, Pressure and Flow instruments (local & remote) and special instruments like EWLI, SWAS System, Gas analyser etc.
- v. Erection and commissioning of Mark VI gas turbine control system, DCS/PLC system and its accessories like microprocessor based system panels, PC, printers, furniture etc.
- w. Commissioning of all Types of Pneumatic operated Valves/Actuators/ Controllers and Relief Valves.
- x. Erection of all types of Hardware like impulse pipes, trays & tray supports, instrument air line, etc.
- y. Erection & Testing of all types of control/instrumentation cables etc.
- z. Erection and commissioning of UPS, Battery, and ACDB
- aa. Erection and commissioning of control panels etc.

1.12.2 SCOPE OF WORK FOR C&I CONTROL PANELS:

- 1 Different types of Microprocessor based panels like PLC Panels, Instrument Panels, etc. are covered in the scope of work for erection and commissioning.
- 2 The unit rate quoted for Installation of control panels, shall include fixing of anti-vibration pads, levelling and alignment, welding, grouting, drilling of bottom gland plates for cable entry as required, closing control panel bottom with suitable flame proof compounds wherever required and checking of internal wiring, instruments, components etc. Unit rate shall also include Testing, Calibration and adjustment of relays, electronic cards and instruments mounted on the panels except the Instruments identified in the BOQ.
- 3 Panels are normally supplied in suite of one / two / three/ four cubicles with bottom base frame and these panels are to be mounted on separate site fabricated base frames as per site condition. The base frames to be properly grouted to the concrete floor or to be TIG welded to the embedded insert plates. The structural steel material for the above will be supplied by BHEL. For fabrication and erection of frame, unit rate shall be paid on tonnage basis.

- 4 For panels to be mounted on trenches, if any channel supports are required, the same shall be provided across the cable trenches over which the base frames of the panels shall be mounted. Similarly for the panels to be mounted on false flooring, if mounting frames are not provided, same shall be fabricated at site. The contractor shall carry out fabrication and erection of these support structures on tonnage rate basis.
- 5 The panels which are supplied for various control systems have to be erected at different places like unit control room/ near the equipment/ various operating floors as per site layout. The contractor shall take the panels to the desired locations either through floor openings or temporary openings. No claims will be entertained for taking the panels to the location owing to change of route or non-availability of openings as per nearest route.
- 6 Minor concrete chipping and grouting works, including supply of grouting material is included in the scope of works.
- 7 If any minor grinding is to be carried out on the cut-outs provided in the panels for mounting instruments like recorders, indicators, console etc., the same shall be carried out by the contractor at no extra cost.
- 8 All the panels and JB's shall be electrically earthed to the nearest earth grid by means of GI wire/Flats as per the instructions of BHEL engineer.
- 9 Painting of fabricated parts and earthing conductors of panels shall be part of the work. Touch up painting for panels, including supply of points shall be carried out by the contractor within the quoted rate.
- 10 Closing the Panel openings and unused drilled holes with non-flammable sealant materials, including supply of above material, shall be part of erection work.
- 11 For panels/ equipment erected by other agencies, commissioning work and troubleshooting are to be carried out by the contractor as per the rate quoted in the schedule.
- 12 Normally the panels shall be supplied with instruments / modules mounted and wired. No separate payment shall be made for commissioning of any instrument/ cards/ components. If dismantling of the above such instruments and rewiring are needed at site, the same shall be carried out at no extra cost. If any instruments/ cards/ components supplied as loose items for safe transit, the same shall be mounted and wired at no extra cost unless specified otherwise in the BOM. Similarly, if any loose supplied instruments /modules are to be mounted and wired on customer panels or any other panels not erected by contractor, the same shall be carried out at no extra cost unless otherwise specified in the BOM. However, if

any major installation/modification/wiring are involved, the same may be carried out as extra work. The decision of BHEL Engineer shall be final in respect of above extra works.

- 13 Dimensions & weights indicated in the BOQ against various panels are approximate only. There may be variations in the weight and dimensions. Variations in depth, height or weight of the panel shall not be considered for payment. Any variation within $\pm 10\%$ of length shall not be considered for payment. However, for variations beyond $\pm 10\%$ in length, price adjustment shall be considered proportional to the length of the panel.

1.12.3 SCOPE OF WORK FOR DCS/PLC AND MARK VI SYSTEMS WITH RELATED FIELD INSTRUMENTS:

- 1.12.3.1 The scope includes erection of all DCS/PLC and Gas Turbine Control Panels(Mark VI) as well as erection of <I> Stations consisting of computer, CRTs, printers, with respective interconnecting cables, power supply, furniture etc. The scope covers integration of all the above said equipments and erection & commissioning.
- 1.12.3.2 BHEL will supply sophisticated MAX-DNA DCS system. The scope of DCS system includes erection of sophisticated microprocessor based systems MAX control panels, I/O panels, Ethernet switching panels, Network Enclosure cabinets, CPU, Engineers workstations, operator workstations, CRTs, server, printers, portable UPS power supply, furniture and interconnecting cables like Ethernet/Fibre-optic etc.
- 1.12.3.3 As these are microprocessor based system panels, experienced personnel shall be deployed in erection and commissioning of these panels and laying and termination of ethernet cable i.e. Data Highway between DCS and PLC and Mark VI systems by skilled personnel
- 1.12.3.4 The instrumentation part includes transmitters, gauges, switches, valves and erection materials like pipes, cables, trays, junction boxes etc. and the erection of these shall be carried out by the contractor as described elsewhere in this section.
- 1.12.3.5 If any instruments/ hardware including furniture supplied as loose item as a part of above packages, but not explicitly mentioned in the description, the same shall be installed at no extra cost.

1.12.4 SCOPE OF WORK FOR INSTRUMENTS:

- 1.12.4.1 The type of instruments to be erected and commissioned shall be as detailed below:
- i) All types of transmitters like temperature, pressure, flow, level transmitters etc.

- ii) Local mounted pressure gauges, DP gauges, thermocouples, RTDs, temperature gauges, temperature switches, pressure switches, DP switches, flow switches and limit switches and flow indicator level switches etc.
 - iii) Air filter regulators, Air lock off valves etc.
 - iv) Panels / Control desk mounted Instruments like indicators, recorder, console and electronic modules etc.
 - v) I / P converters and local controllers.
 - vi) Pneumatic operated control valves, trip valves, solenoid valves, power cylinders, etc. and electrically operated valves.
 - vii) Special instruments like vibration sensors, electronic water level indicator, Gas analyser, PC based instruments, etc.
- 1.12.4.2 Prior to installation, all the local & remote Instruments, thermocouples/RTDs, I/P converters, etc. shall be calibrated. Similarly, limit switches, flow switches, level switches, solenoid valves, air filter regulator, purge meters, etc. shall be checked for proper operation.
- 1.12.4.3 The scope of work for each instrument shall include calibration, installation, loop checking, commissioning and trouble shooting until satisfactory performance as per operational and system requirement and maintenance till the end of contract period or trial operation whichever is earlier.
- 1.12.4.4 In case any instrument requires recalibration to achieve the expected performance, the same shall be carried out at no extra cost. If any re-calibration or replacement of instruments and rechecking of cable termination is found necessary during commissioning, the same shall be done at free of cost.
- 1.12.4.5 If any instrument is to be relocated for satisfactory performance, the same shall be carried out by the contractor.
- 1.12.4.6 Fabrication and installation of racks and supports for instruments, wherever required, shall be carried out by the contractor. Steel materials required for fabrication shall be supplied by BHEL.
- 1.12.4.7 The scope shall also include marking Tag numbers on the instruments or racks, either by paint or a separate tag plate as per BHEL Engineer's directive.
- 1.12.4.8 For field mounted instruments, pre-fabricated canopies shall be provided by BHEL. Mounting of canopies shall be done by the contractor as part of scope.
- 1.12.4.9 The scope of work for pressure/differential pressure transmitters, gauges, switches, shall include fixing the instruments on the racks / supports along with manifolds, and associated fittings and clamps.
- 1.12.4.10 The scope of work for Temperature transmitters, I/P converters, Air filter/Air lock off valves, Purge meters, Rotameters, position transmitter, probes etc shall include fixing the instruments on the racks / supports along with associated fittings and clamps.

- 1.12.4.11 The scope of work for control room mounted instruments shall cover mounting of instruments on panels / desk wiring, minor grinding on the cut out of panels for proper fixing.
- 1.12.4.12 The scope of work for erection of Casing temperature thermocouple of turbine/ metal temperature thermocouple (MTM) shall cover laying, dressing and clamping, supply and fixing of tag plates, etc.
- 1.12.4.13 The scope of work for erection and checking of thermocouple, RTD etc. shall include cleaning of thermo well stubs threads using tap sets, fixing of thermo wells, seal welding of thermo well, wherever required as per BHEL directive of site engineers.
- 1.12.4.14 The scope of work for temperature switches, gauges shall include providing suitable support for capillary type temperature Gauges/switches besides the works covered above for RTD & T/C.
- 1.12.4.15 The scope of work for erection and commissioning of float type Level switches includes fixing of switches on float chambers and fixing of float chambers on stand pipe, any minor modification required to match Float chamber with tapping point, providing supports wherever required etc.
- 1.12.4.16 The scope of work for Electronic type Level switches includes fixing of Electrode standpipe, Electrodes, Electronic unit, any minor modification required to match Float chamber/ Electrode standpipe with tapping point, integration of all loose supplied items etc .
- 1.12.4.17 The scope of work for special instruments like, Electronic water level indicator, Gas analysers, SWAS Analyser, etc. shall include installation of all loose items which are not explicitly mentioned, but comes as part of the system, integration of total system and commissioning. The quantities of loose supplied items are approximate only. No extra payment will be applicable for any variation in quantity or for any additional items supplied as part of equipments.
- 1.12.4.18 For Special Instruments like, Gas Analysers, SWAS System, DCS/PLC vendor support shall be provided by BHEL for commissioning. The contractor shall provide necessary assistance for commissioning activities.
- 1.12.4.19 All instruments are generally covered in the BOM. However, if any instruments not covered, but requires being erected/commissioned, same shall be carried out by the contractor.
- 1.12.4.20 In case of Instruments that are mounted and supplied along with main equipment, the contractor shall carry out removal, calibration, re-fixing and commissioning of same, as per requirement.

1.12.5 SCOPE OF WORK FOR IMPULSE PIPES:

- 1.12.5.1 Different types of impulse pipes, like alloy steel, carbon steel, stainless steel of different sizes and thickness shall be supplied with suitable fittings like coupling, sockets, root valves, drain valves, manifold, condensing pots, syphons, tees, bends, nut and tail piece.
- 1.12.5.2 The scope of work for impulse piping shall include site routing, cold bending, tig / arc welding of unions, connector Nuts and tail pieces, sockets, nipples, equal tees, couplings, condensing pots, syphons, root valves, isolation valves etc., fixing of manifolds and supporting with suitable fixtures and 'U' clamps at an interval of 200-300 mm gap and painting as per BHEL/customer specification and site engineers instructions. The scope also includes supply of U clamps, fasteners, paints, etc.
- 1.12.5.3 Welding of impulse pipe for High Pressure Lines shall be carried out by High Pressure welder.
- 1.12.5.4 Fabrication and installation of supports for impulse pipes shall be carried out by the contractor. Steel materials required for fabrication shall be supplied by BHEL.
- 1.12.5.5 For scope of painting, refer Scope of Painting clause.
- 1.12.5.6 Suitable root valves will be provided by BHEL on the tapping point wherever required. Wherever the dia of the impulse piping is not matching with valve outlet dia., reducers to be provided and necessary welding to the same to be done at site as part of impulse pipe erection. The reducers will be supplied by BHEL and the contractor shall carry out the welding. No separate rate will be paid for welding of the reducers.
- 1.12.5.7 TIG-welding sets, welding transformer/generator rectifier, Hydraulic bending machines, DPT kits, Hydraulic testing pumps required for pressure testing of impulse pipes shall be arranged by the contractor. Similarly, consumables such as welding electrodes, gas, Tungsten rods etc., filler wire shall be arranged by the contractor within the quoted rate.
- 1.12.5.8 The contractor shall obtain necessary approval for welding electrodes, filler wire from BHEL welding engineer at site.
- 1.12.5.9 Impulse pipes Welder shall undergo test and get approval from BHEL welding engineer according to the nature of welding.
- 1.12.5.10 For longer route lengths of impulse pipes, the contractor shall provide Tag numbers at appropriate locations as directed by BHEL site engineer at no extra cost.
- 1.12.5.11 Hydraulic test shall be conducted for all impulse pipes after completion of erection as per site engineer's directive, as part of the work.

1.12.6 SCOPE OF WORK FOR COPPER/ SS TUBES:

- 1.12.6.1 Different sizes of copper tubes of different thickness with or without PVC coating shall be supplied in standard lengths of 15 Mtr Coils and SS tube shall be supplied in standard length of 6 meter. The connectors and tees will be of brass/SS of different sizes as per site requirement.
- 1.12.6.2 The scope of work includes site routing, bending, providing supports, fixing of connectors, unions, valves, tees, etc, and connecting to the instrument air line instruments. The scope also includes providing tag plates on instruments / power cylinders.
- 1.12.6.3 If copper/SS tube length is more than ½ mtr, suitable support shall be provided either by angle or trays. Protective angles to be used for copper tube routing. The support materials shall be supplied by BHEL.
- 1.12.6.4 Copper/SS tubes shall be clamped with suitable clamping materials. Supply of suitable Aluminium clamps and tag plates are under contractor's scope.
- 1.12.6.5 Leak test shall be carried out after completion of tubing works as per guidelines.

1.12.7 SCOPE OF WORK FOR INSTRUMENT AIR LINES: (GI PIPES)

- 1.12.7.1 Different type of GI pipes of different thickness class shall be supplied along with GI fitting accessories like union, coupling, tee, reducers, elbow, valves, etc
- 1.12.7.2 The scope of work for erection of instrument air lines includes site routing, providing supports, fixing "U" clamps, fixing of loose supplied GI accessories mentioned as above as per the drawings, providing fresh threading as required for jointing with unions, valves and all type of other fittings as required in the system. The scope shall include supply of U clamps, Teflon tapes and bolts, etc, also.
- 1.12.7.3 Teflon tapes shall be used for tightening all the joints. No bending, welding etc. is allowed.
- 1.12.7.4 After installation of instrument airlines, the line shall be blown and leak test shall be conducted for all the joints as per the guidelines given in section VII.

1.12.8 SCOPE OF WORK FOR ELECTRIC & PNEUMATIC ACTUATORS:

- 1.12.8.1 Pneumatic actuators shall be calibrated at site.
- 1.12.8.2 For calibration of any Pneumatic Actuator at field, temporary air supply, if required, shall be arranged by the contractor.
- 1.12.8.3 All calibration instruments required for calibration of actuators shall be arranged by the contractor.

1.12.8.4 For all electrical actuators of the valves, functioning, setting and performance of limit switches/torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated.

1.12.9 SCOPE OF WORK FOR THE INSTRUMENTS MOUNTED AND SUPPLIED ALONG WITH EQUIPMENT/ SKIDS

1.12.9.1 Scope of work covers removal, re-calibration, re-fixing, re-termination of cables, checking the continuity, replacing any defective parts or replacing the total instrument, if required.

1.12.9.2 The scope also covers collecting the replacement instruments/parts from BHEL/customer stores, stockyard etc.

PART – I CHAPTER- XIII

ILLUMINATION

1.13.0 SCOPE OF WORKS FOR ILLUMINATION PACKAGE

The scope of works of illumination covers mainly in HRSG/GT area only. The scope of items to be supplied by the contractor is indicated in the BOQ. If any conduit accessories other than those supplied by BHEL is required for completion of illumination system, the same shall be arranged by the contractor at free of cost.

The following shall be part of the illumination work.

- a. Installation of main lighting panels with switch controls.
- b. Installation of GI conduits
- c. Installation of wiring materials for lighting system.
- d. Installation of junction boxes, clamps, connectors, flexible GI conduits etc. required for lighting system wherever specified.
- e. Installation of cable lugs, ferrules, cable identification tags, cable dressing materials etc. as required.
- f. Supply of complete hardware for installation of lighting system like clamps, bolts, nuts, brackets, anchor fasteners etc.
- g. Supply of adequate quantity of touch up paint.
- h. Supply of all consumables and hardware required for installation.
- i. Supply and installation of other accessories which have not been specifically indicated but may be required for complete of installation.
- j. Arranging all scaffolding and platforms for erection of cables, light fittings, DBs etc.

1.13.1 GENERAL INSTALLATION REQUIREMENTS FOR ILLUMINATION PACKAGE

- 1.13.1.1 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instruction/recommendations where the same are available.
- 1.13.1.2 Equipment shall be installed with neat workmanship so that it is level, plumb, square and properly aligned and oriented.
- 1.13.1.3 Cable installation work shall mean laying of cables either in ground or on trays, inside trenches, overhead trays, in conduits etc., dressing and clamping, jointing and termination inclusive of supply of necessary ferrules, tapes etc. and other accessories, grounding of cable armour/cable screen.
- 1.13.1.4 Lighting fixtures of appropriate type as per the lighting layout drawings shall be installed by the sub contractor. The exact mounting will be decided at site depending upon the actual space/other facilities available at site. All materials required for mounting the fixture shall be supplied and installed by the contractor.

- 1.13.1.5 The bracket for mounting the lighting fixtures on boiler platforms shall be fabricated at site using 40 mm GI conduit with a reducing socket to suit the fixture and clamped to the handrails. However, the clamping of these conduits at points of large vibrations should be avoided. The fixing shall be strong enough to withstand vibrations and wind velocity.
- 1.13.1.6 The location of the lighting panels and lighting fixtures with circuit designation shall be as shown in lighting drawings. The various receptacles, switches etc. at various places shall be installed as shown in the drawings. The lighting layouts furnished by purchaser shall indicate the approximate location of fixtures. The contractor shall determine the exact location in order to avoid interference with piping/cable trays or other equipment and to avoid objectionable shadows.
- 1.13.1.7 Before installation, light fittings, switches, receptacles etc. shall be checked for tightness of internal connection and insulation value. Fixtures shall be firmly supported from structures. Clamps may be bolted or welded to the existing steelworks. In case of concrete structures, fixtures will be fixed with the help of anchor fasteners. In false ceiling areas fixtures shall be supported from the true ceiling.
- 1.13.1.8 Main Lighting DB's shall be mounted on floor and LPs shall be mounted on floor or on the walls/columns/steel structures at the locations as indicated in the drawings. All materials required for fabrication shall be supplied by the contractor to suit site requirement at no additional cost and this shall be taken care in supply and erection.
- 1.13.1.9 Suitable fixing provision for mounting LDB on floor would be made by the contractor. The sub contractor will supply necessary foundation bolts and do the grouting to fix up the LDBs.
- 1.13.1.10 DBs shall be installed by fastening to studs of not less than 4 mm dia. which will be suitably grouted/welded to the wall/column by the sub contractor. All the required accessories including studs for the erection of the panel shall be supplied by the sub contractor. If mounting channels are required for LDBs, the same will be provided by the sub contractor.
- 1.13.1.11 Unless specified otherwise in the drawings, the height of the centre line of lighting panels from the floor shall be 400 mm.
- 1.13.1.12 All lighting wires shall be run in separate conduits. Not more than two circuits shall be run in each. Each phase shall be run in separate conduits only. Size of conduit shall be selected as per the table given below:

Size of Wire	Max. Number of wires in
7/20 Copper	25 mm conduit - 4 wires

- 1.13.1.13 Lighting wires from lighting panels to junction boxes and junction boxes to lighting fixtures, switch boxes and receptacle boxes shall run in conduits (Rigid/flexible).
- 1.13.1.14 All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.
- 1.13.1.15 Wires shall not be pulled through more than two equivalent 90 deg. Bends in a single conduit run. Wherever required, suitable conduit junction boxes/pull boxes shall be provided. All types of wiring, concealed or unconcealed shall be capable of easy inspection.
- 1.13.1.16 Receptacles and lighting circuits shall be fed from different circuits. The switch controlling these circuits shall be on the live side (phase wire) of the circuits.
- 1.13.1.17 All lighting wires shall be crimped using suitable type of solderless, crimping, tinned fork type copper lugs. Cost of the lugs shall be included in the erection price of wire.
- 1.13.1.18 All cables from MCC to Main DB and Sub-DBs shall be laid in cable trenches, cable trays along with the power cables and shall be clamped properly.
- 1.13.1.19 All cables from sub-DBs to the lighting fixtures shall be run along the column or structures with suitable clamps and dressed neatly.
- 1.13.1.20 Wherever necessary, GI pipes may be used for running the cable for mechanical protection. Proper lugs should be used for terminating the cables.
- 1.13.1.21 For HRSG light fittings, outgoing cable from each circuit of lighting panel shall be 1 run of 3 C x 2.5 sq. mm PVC, Al or Cu cable.
- 1.13.1.22 Lighting fixtures, receptacles, switches, conduits and junction boxes etc., shall be properly earthed in compliance with the provision of I.E. rules and applicable Indian standard amended upto date.
- 1.13.1.23 A continuous earth conductor of 4 SWG GI wire shall be run all along the entire length of the conduit between the fixture and the corresponding lighting panel where it will be connected to the station earth.
- 1.13.1.24 For fixtures in hazardous areas, the third core of each single-phase armoured cable circuit shall be used as earthing conductor.
- 1.13.1.25 Wherever necessary, GI wire shall be run along with cable as instructed by engineer in- charge.
- 1.13.1.26 The grounding shall be done by conductors of suitable size and the same shall be connected to the risers of Owner's main ground mat.

Lighting distribution panels, 25 x 6 mm GI flat or 50x 6mm G.I. flat.

- 1.13.1.27 Equipment will generally be furnished with two separate ground pads with tapped holes, bolts, nuts and spring washers etc. If however the same are not furnished, contractor shall drill and tap holes and provide bolts, nuts, spring washer etc. for connection.
- 1.13.1.28 Equipment ground connections, after being checked and tested by the engineer, shall be coated with anti-corrosive paint.
- 1.13.1.29 Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such switchboards, panels, cabinets, junction boxes, fittings, fixtures, etc. shall be effectively grounded.
- 1.13.1.30 Earthing conductors along their run on walls and columns shall be supported by cleating with approved materials/welding at intervals of 750 mm.
- 1.13.1.31 Supply of 50dia,100dia & 200dia GI pipe bends for cable termination upto equipment JB of motor, LPB, Receptacles, Lighting poles, etc. is in the scope of contractor. The cost of this shall be included in the erection cost of the respective item.

PART-I CHAPTER-XIV

CABLES&TRAYS, JB, PB, EARTHING, PAINTING, CIVIL, COMMISSIONING, CALIBRATION, ETC

1.14.1 SCOPE OF WORK FOR CABLES

BHEL will supply HT and LT cables (11kV/ 6.6 kV/ 1.1 kV, Armoured/ Unarmoured, Aluminium /Copper PVC FRLS insulation) of different sizes. The scope of work for cables covered in this tender is as below.

1. The scope includes laying & termination of cables, drilling of gland holes on gland plates of the panels/JBs, fixing of glands, ferrules, tag plates with necessary numbering and dressing of cable, as per BHEL specification and BHEL engineer's instructions.
2. The scope shall also include supply of clamping materials, ferrules, tag plates, lugs up to 2.5 sq. mm. Contractor scope of supply of materials shall be as per BHEL's specification as detailed in Section VI
3. The scope of work for HT cables shall include fixing of Trefoil clamps and clamping also.
4. Separate rate shall be paid for cable termination of Higher size cables. Such cables will be indicated in the BOM/ Rate Schedule. For other cables, a composite rate covering laying and termination shall be applicable.
5. Cables shall generally be laid on cable trays. However, if the cables are to be routed through or laid in duct bank, conduits, cable shafts etc, the same shall be carried out by the contractor at no extra cost
6. For some of the cables, cable trays will not be provided either by BHEL or by customer and such cables have to be routed on the steel angles as per site condition. Steel angles required for the same will be supplied by BHEL free of cost. Even if the cable support are arranged by the other agency, cable dressing shall be carried out for the cables laid by the contractor. Any fabrication required at site for cable support shall be carried out by the contractor.
7. The contractor shall carry out cable dressing and clamping for all the cables laid by the contractor. However, if cables like illumination cables or any cables of lesser quantity for which no separate trays have been allotted are laid on the same trays, the contractor shall do clamping along with the cables laid by others. **All the dressing material such as Aluminium/GI strips, PVC ties etc. required for cable shall be arranged by the contractor.**
8. Wherever the equipment installed by another agency where they have not provided with cable accessories such as cable gland, holes etc. contractor shall co-operate to get the same done.

9. The scope of work for cable laying shall also cover the following works.
 - a) Modification such as rotating the terminal box through 90° or 180° as required.
 - b) Enlargement of cable entry holes, if necessary, by chipping/tapping or any modification required fixing of cable glands
 - c) Drilling of gland plates of equipment if not done already.
 - d) Reaming and relocating holes at actual point of entry of cable or conduit in terminal boxes, outlet boxes, pull boxes etc. cleaning off the debris/trapped material from conduit/ducts.
 - e) In case any existing structure is affected/damaged due to installation work of cables the contractor shall repair the same to the satisfaction of Site Engineer
- 10. The approximate number of termination for the purpose of estimation to be for control and pair cable shall be assumed as follows: The average RUN length shall be considered as 150 mtrs. However, 10% of the cable the average length shall be considered as 30 mtrs.**

CABLE TERMINATION

11. The scope of termination shall include, termination of cables on various equipment installed by others. The contractor shall work in co-operation with other agencies in obtaining correct direction of rotation and commissioning of the equipment.
12. The insulating sleeves shall be of fire resistant and be long enough to over pass conductor insulation and shall be properly sized.
13. Termination of all the cables laid by the contractor is included in his scope. The work of testing and reconnecting, changing of connectors, the tenderer without additional cost shall carry out rearrangements of leads if required.
14. The contractor shall provide Tools/ equipment required for the connections and termination of cable wherever necessary.
15. Necessary lugs above 2.5 sq. mm shall be supplied by BHEL.
16. After cable terminations, the debris shall be removed then & there
17. For HT cable termination suitable termination kits shall be supplied and HT cable termination shall be part of installation of HT termination kits.
18. Only printed ferrules should be used and the contractor shall arrange necessary ferrules printer at site.

1.14.2 SCOPE OF WORK FOR CABLE TRAYS/ SUPPORTS/ CONDUITS/ FLEXIBLE CONDUITS:

A.CABLE TRAYS

- a. Scope of cable tray works covers erection various sizes of ladder & perforated trays with accessories such as coupler plates/fixing plates, anchor bolts, fasteners etc.
- b. The scope of erection shall also covers erection all type of trays and its accessories such as coupler plates/fixing plates, anchor bolts, fasteners etc, fabrication of standard tray accessories such as TEES, Reducers, Bends (vertical and Horizontal), cross etc wherever required, and making of offsets by means of cutting standard tray sections and inserting suitable size of trays to match with the existing arrangement.
- c. The scope includes erection of trays and accessories, fabrication and erection of trays accessories and modification of straight trays.
- d. If tray covers are supplied same shall be erected after completion of cable laying. GI strip clamps are to be used for fixing the tray covers.
- e. Welded Joints of trays shall be painted with red lead and aluminium paint in turn with bitumen as per IS 3043. The scope also includes supply of paints, thinner, other consumables and brush etc.

B. RIGID & FLEXIBLE CONDUITS

- a. Cables shall normally be laid on cable trays. However, in case of shorter routes where trays are not possible, suitable GI pipe/flexible conduits shall be used. GI pipes and flexible conduits shall be supplied by BHEL.
- b. The scope of works for flexible conduit includes drilling of the holes on the plates, fixing of the end connectors, providing suitable supports and fixing tag marks wherever specified as required by BHEL. The supply of suitable clamps, fasteners and tag plates are in contractor's scope.
- c. Fixing end connectors shall be part of scope of flexible conduit laying.

1.14.3 SCOPE OF WORK FOR JUNCTION BOXES/ PUSH BUTTON BOXES

Different type of Junction boxes/Push button boxes shall be supplied. The scope of installation of Junction boxes/Push button boxes shall be as follows:

1. The scope for erection of junction boxes/push button boxes shall include providing necessary supports, drilling of bottom gland plates for cable glands as required, Painting the tag No of JB or fixing a separate tag plate as required on junction boxes/push button boxes, minor chipping, grouting as required for mounting the JB/PB and supply of all bolts and nuts (Fasteners) including grouting bolts as required for mounting the junction box/push button, fabrication and fixing of supports.
2. The contractor shall close all unused holes on the gland plates using grommet or other suitable material issued by BHEL, at no extra cost.
3. All bolts and nuts (Fasteners) required for mounting the junction box shall be arranged by the contractor.
4. If any intermediate JB's are required to terminate power cables for drives, the same shall be installed and also any modification like replacement of terminals, enlarging gland holes etc. required to accommodate power cables shall be carried out as part of this works.
5. The contractor shall prepare JB terminal drawing for each JB, indicating tag nos. for instruments, JB TB & TE no, core/ pair no of all incoming/outgoing cables. Such drawing shall be laminated and pasted inside the respective field JB. 2 Nos. of the laminated drawing per JB are to be supplied.
6. The mounting of JB's for Fire Detector as well as installation of miscellaneous conduiting materials will be part of scope.

1.14.4 SCOPE OF WORK FOR FABRICATION & INSTALLATION OF STEEL MATERIALS

- 1.14.4.1 Scope of steel fabrication and installation covers, fabrication and installation of various type of supports for cable tray, Panels, instruments, impulse pipes, GI pipes, support angles for copper tubing, mounting frames for JB, Control Box/Panel, local PB Stations, canopy for local instruments and local instrument rack etc. wherever required.
- 1.14.4.2 The fabrication steel materials such as angles, channels, plates, etc shall be supplied in standard lengths by BHEL. Fabrication shall be carried out by the contractor as per schemes in consultation with site engineers.
- 1.14.4.3 Immediately after fabrication, primer shall be applied to prevent corrosion. The installation shall be carried out only after applying the primer as detailed in painting clause.

1.14.4.4 All fabricated steel materials shall be painted as detailed in the scope of painting.

1.14.4.5 A composite rate shall be quoted for fabrication and installation of steel, on tonnage basis. The above rate shall include supply of paints and painting, grouting and grouting material as required.

1.14.5 SCOPE OF ABOVE GROUND EARTHING

1. The scope of work shall include installation of earthing and associated fittings. Civil agency will provide earthing system comprising of main earthing conductor buried in soil, embedded in concrete inside the building. Installation of earthing conductors for connecting equipment pertaining to BOILER/GTG/BOP area to the plant main earth grid shall be carried out by the contractor.
2. The scope shall cover supply of fasteners, Saddles, Spacers, lugs, minor civil works etc.
3. Different type of earthing materials shall be supplied by BHEL and the contractor shall lay and connect the earthing materials as per site requirement.
4. Earthing System Installation scope covers, earthing of all cable trays in inside/outside plant building as well as inside the trenches at an interval as detailed in section VII metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, neutral points of various systems/equipment, panels, motors, JB, push button boxes etc. as listed in various drawings
5. The connection between earthing pads/ terminal to the earth grid shall be made short and direct and shall be free from kinks and splices.
6. Equipment bolted connection after checking and testing shall be painted with anti-corrosive paint/ compound. Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
7. **For Electronic earthing, separate conductor shall be used for flow of earth fault current. All Electronic panels shall be connected separately to Electronic bus which in turn will be connected to electronic earth pit.**

1.14.6 SCOPE OF PAINTING

1. The scope of painting generally includes for all the steel works such as supports, racks, frames, canopy, impulse pipes, Transformer, Bus ducts, as detailed in Scope of work of respective equipment besides touch up paints wherever required.

2. **The scope also includes supply of paints, primers, tools/consumables like brushes, rollers, emery papers, thinner etc.,**
3. Touch up painting only is generally required for trays, control panels, junction boxes and full painting shall be required only for specific equipments as per the scope of erection.
4. For any bare copper material requirement, painting as desired by the site shall be carried out by the contractor at free of cost.
5. All damaged painted surfaces shall be cleaned and as detailed above.
6. All damaged galvanized surfaces including cable trays shall be coated with cold galvanizing paint.
7. Supply of paints and primer shall be in line with scope of painting of Main Equipment.

1.14.7 SCOPE OF CIVIL WORKS

1. The scope of civil works covers minor civil works like drilling, chipping and punching & opening in concrete floors, slabs, brick walls, grouting of foundation bus duct columns, base frame of panels, Transformer etc. Scope of civil works also covers minor civil works required for installation of push button stations, Junction Boxes.
2. Scope of civil works includes supply of grouting materials like cement, sand, etc., and cleaning of all debris at free of cost.
3. More details regarding scope of civil works are given in the respective equipment erection.

1.14.8 SCOPE OF COMMISSIONING OF EQUIPMENT ERECTED BY OTHER AGENCIES

The commissioning of the Electrical/C&I items erected as part of Mechanical Works -like Generator, Drives, Actuators, Control Valves, Solenoid Valves, etc.- shall be part of the scope of work.

Separate group shall be identified for commissioning. The above group shall be available right from Trial run to full load operation including shift operation.

The scope of work covered herein also includes collecting the replacement instruments/parts from BHEL/customer stores, stockyard etc.

14 GENERATOR

- a) Cable identification, checking and meggering.
- b) IR value, measurement of winding resistance etc.
- c) Dry out if required to improve IR value.

- d) Checking the bushing
- e) OCC, SCC and other protection tests.
- f) Attending to any defects till the handing over of the unit to customer

1) ELECTRICAL (ALL TYPE OF DRIVES AND MOTOR OPERATED VALVES)

- i) Cable identification, checking and meggering.
- ii) IR value of motor, measurement of winding resistance etc.
- iii) Dryout all the motors if required to improve IR value.
- iv) Limit switch and torque switch setting
- v) Calibration of Electronic cards, modules etc. and fixing the same if supplied as loose item.
- vi) Checking direction of rotation of motors and testing and commissioning from local as well as remote.
- vii) Attending to any defects till the completion of contract period.
- viii) Replacing defective components like limit switches, electronic cards etc.

2) PNEUMATIC ACTUATORS

- a) Calibration and setting of instruments mounted on the actuators and setting stroke length of the actuator.
- b) Servicing of positioners, position transmitters, limit switches, solenoid valves, air lock-off valves, removing/replacement of defective components, copper tubes etc., if necessary.
- c) In case the actuator has to be removed for attending to any mechanical problems proper removing of copper tubes, cables etc. reconnecting and re-commissioning of the actuators is to be done.
- d) Testing and commissioning and checking the remote/local operation in Auto as well as Manual mode.
- e) Fixing of instruments if supplied as loose items. (As referred in sl.no. b above)
- f) Attending to any defects till the handing over of the unit to customer by BHEL.

3) FLOW METERS/SWITCHES

- a) Checking the calibration and servicing if required.
- b) Setting the alarm value
- c) Replacement of defective components if any

4) LIMIT SWITCHES & LEVEL SWITCHES

- a) Checking the operation
- b) Replacing defective components if required

5) SOLENOID VALVES

- a) Checking the healthiness of oil
- b) Checking the operation
- c) Replacement of defective components if required.

6) TEMPERATURE ELEMENTS (MOTORS AND GENERATORS WINDING AND BEARING)

- a) Checking the healthiness
- b) Replacement of defective element (only for bearing)

7) LEVEL GAUGES

- a) Checking the calibration
- b) Fixing of bulbs and extending Power supply
- c) Replacing defective components.

HOIST:

All cabling will be carried out by the vendors. However the scope of works of hoist covers the checking of control panels wiring, field wiring like push button, motors, limit switch etc., fixing of Trailing cables, and making ready for load test by mechanical agency etc.

1.14.9 SCOPE OF CALIBRATION

- 15 Contractor shall calibrate all the local instruments, panel mounted instruments including transducers, protective relays, Recorders, Indicators etc. that will be supplied along with equipments mounted in or in loose
- 16 Contractor shall calibration records as per the format CP:PEX:FOX enclosed in the tender specification.

- 17 All testing Instruments/ Equipment deployed for calibration shall be calibrated before taking it into service. A copy of calibration certificate shall be submitted to BHEL Engineer for his verification and approval.
- 18 All testing instruments shall have calibration certificate issued by recognized/accredited agencies.
- 19 **BHEL shall provide vendors supports for proprietary type of microprocessor-based instruments, protective relays, which requires software loading and programmer etc. However overall responsibility lies with contractor and Contractor shall provide all supports like manpower, standard T&P, Instruments etc for calibration and testing of above proprietary type instruments**
- 20 **If BHEL is unable provide or arrange vendor support for above mentioned proprietary instruments, contractor shall carry out the calibration through authorized agency, at extra cost. The actual cost of such calibration carried out by out side agency shall be absorbed by BHEL. However if above such calibrator is available with BHEL at site the calibration shall be carried out by the contractor at free of cost.**

1.14.10 SCOPE OF PRE-COMMISSIONING/COMMISSIONING AND POST COMMISSIONING WORKS :

1. The scope of commissioning works covers commissioning of all instruments/equipments/systems covered in the BOQ including loop checking and establishing the operation of instruments/equipments/systems to meet plant commissioning/operation. BHEL will provide vendor supports for special or proprietary type instruments/systems and contractor engineers/supervisors shall associate with the vendors and provide necessary manpower, T&P etc. The contractor shall be responsible for overall commissioning of all the instruments and systems covered in the BOQ.
2. Scope of commissioning starts with the commissioning of various equipment/ instruments/ systems erected by the contractor and making them available, as required, for the various commissioning activities of the main plants. The commissioning activities of the main plant shall be as below:

GAS TURBINE:

- i) Trial run of various equipment.
- ii) Cranking of GT
- iii) FSNL
- iv) Synchronisation
- v) Full load operation

FOR HRSG:

- i) Gas admission
- ii) Boiler alkali boil out.
- iii) Steam blowing.
- iv) Safety valve floating.
- v) Admission of steam to process line.

The above commissioning activities, tests, trial runs may have to be repeated till satisfactory results are obtained to the satisfaction of customer / consultant / statutory authorities like boiler inspector, electrical inspector etc.

The contractor shall co-ordinate with other contractor's during the above main plant commissioning activities to ensure successful commissioning of total plant.

3. The pre commissioning activities of the plant will start with run of various equipments prior to Cranking of GT and commissioning operations shall continue till the unit is handed over to customer. The contractor shall simultaneously start commissioning activities for the equipment erected to match with the various milestone activities of commissioning programme of the project.
4. Contractor shall arrange specialized commissioning engineers, supervisors, electricians, instrument mechanics in each area to be associated with BHEL commissioning staff. Contractor shall earmark separate manpower for various commissioning activities. The manpower shall not be disturbed or diverted. It shall be specifically noted that above employees of the contractor may have to work round the clock along with BHEL commissioning engineers involving considerable payment of overtime, which forms part of Contractors Scope
5. The mobilization of these commissioning groups shall be such that planned activities are taken up in time and also completed as per schedule and the work undertaken round the clock if required. It is the responsibility of contractor to discuss on day to day / weekly / monthly basis the requirement of manpower, consumables, tools and tackles with BHEL engineer and arrange for the same.
6. If at any time the requisite manpower, consumables, T & P are not arranged by the contractor to meet the schedule, BHEL shall make alternate arrangements and recover the cost with overhead from the running bills of the contractor.

7. After erection of various equipment prior to commissioning and after commissioning, protocols have to be made with BHEL's customer. The formats will be given by BHEL and have to be printed by the contractor in adequate numbers.
8. For electrical works, 415 volts and above, the contractor has to bring qualified electricians and the total work has to be certified by electrical license holder.
9. In case any rework/repair/rectification/modification/fabrication etc. is required because of contractor's faulty erection which is noticed during commissioning at any stage, the same has to be rectified by the contractor at his cost. If during commissioning, any improvement / repair / rework / rectification / fabrication / modification due to design improvement / requirement is involved, the same shall be carried out by the contractor promptly and expeditiously. Claims if any, for such works from the contractor shall be governed by clauses covered elsewhere.
10. During commissioning activities and carrying out various tests, if any of the instruments has to be temporarily erected and commissioned to suit the commissioning activities, the contractor have to carry out the erection of the same. After completion of activities the temporary systems have to be removed and returned to stores and no extra rate shall be paid for this
11. Minimum requirement of Man Power for commissioning works per unit shall be as follows:

Engineer (Electrical)	-1
Supervisor (Electrical)	-2
Technician (Electrical)	-5
Engineer (C&I)	-1
Supervisor C&I)	-2
Technician (C&I)	- 5

The above commissioning group shall be identified at the Pre-commissioning and commissioning time. The above commissioning group shall have the knowledge of various systems referred in the tender and also should have adequate experience. The above manpower for commissioning is only tentative and for any additional manpower as per site requirement the same shall be arranged by the contractor.

If the contractor fails to deploy the above Engineer/Supervisor/ Technician at appropriate time of commissioning, no payment shall be made against commissioning activities as per terms of payment.

12. All the T&P instruments required for commissioning are to be arranged by the contractor. (However, any special instruments, which are of proprietary nature, shall be arranged by BHEL.)
13. It shall be the responsibility of the contractor to arrange and complete all the testing, pre-commissioning and commissioning activities for the particular equipment as per relevant standard, code of practice, manufacturer's instructions and BHEL norms. All the above will be witnessed by the BHEL engineers and reports signed shortly. Contractor shall follow checklist of BHEL and testing & commissioning activities shall be carried out in accordance with the checklist.
- 14. The scope of commissioning shall also cover the commissioning of the equipment/drives erected as part of Main Equipment.**

1.14.11 STORAGE

1. The equipment should be preferably in its original package and should not be unpacked until it absolutely necessary for its installation. The equipment should be best protected in its cases. It should be arranged away from walls.
2. The wooden pallet provided for packing itself can be retained for raised platform to protect equipment from ground damp, sinking into ground and to circulate air under the stored equipment. This will also help in lifting the packing with fork lift truck.
3. Periodic inspection of silica gel placed inside the equipment is necessary. It has to be replaced when decolorisation takes place or regenerated. BHEL shall supply the material and contractor shall replace the same.
4. Due care should be taken to ensure that the equipment is not exposed to fumes, gases etc. which can affect electrical contacts of relays and terminal boards.
5. The storage room and the equipment should be checked at regular interval of 3 months to ensure protection from termites, mould growth, condensation of water etc. which can damage the equipment. Contractor shall keep BHEL informed about such problem and try to rectify the problem at his risk and cost.
6. All the equipment, materials and goods kept in the store room should be identified and registered in a book. Inspection report should be recorded. Any discrepancy observed should be communicated to site.
7. Packing material shall be retained if the cubicle is to be repacked after inspection.
8. Sub-Assemblies
 - All sub-assemblies should be kept in a separate place where it is easily accessible.

- Sub-assemblies should have a protective cover in case it is stored without wooden packing/case to prevent accumulation of dust. Silica gel packets should also be kept along with it.
- Sub-assemblies should not be stacked one above the other.

9. Loose items (wherever applicable)

The loose items supplied for the main equipment falls into various categories like tools, cables, prefabricated cables, console inserts, recorders, modules and display units, printers, sensors and transducers, cable glands, cable ducts, frames etc. are to be categorised and stored separately.

1.14.12 MATERIALS/CONSUMABLES TO BE ARRANGED BY THE CONTRACTOR FOR ERECTION AND COMMISSIONING AS PART OF THE SCOPE AT FREE OF COST.

- 01 Welding electrodes and gas.
- 02 Provision for Temporary Scaffoldings.
- 03 "U" Clamps with nuts and washers for impulse pipes and GI pipe clamping(if applicable).
- 04 Tag Plates.
- 05 Insulation tape.
- 06 Teflon tape for GI pipe coupling(if applicable).
- 07 Paints required for primer coating and final coating of synthetic enamel paint of approved colour and consumables like thinner, brushes, emery paper etc.
- 08 Solder wire (Lead) -(60/40)
- 09 Protocol/Calibration report sheets as per BHEL Format.
- 10 Panel/JB Sealing compound material (for cable entry from bottom/Top of Panel).
- 11 PVC cable tie, Aluminium or GI strips and fasteners for clamping of cables and other dressing materials required for cable dressing, grommets.
- 12 Ferrules, sleeves for cables
- 13 PVC cable tie, or Aluminium strip and fasteners (for clamping of cables), lugs upto 2.5 sq.mm
- 14 Fasteners required for fixing JBs and Push button Stations etc.

1.14.13 TECHNICAL REQUIREMENTS FOR SUPPLY ITEMS

1 CABLE LUGS:

- | | |
|---|--------------------------|
| a) Type: | Solderless crimping type |
| b) Material | Copper / Aluminium |
| c) Whether tinning required (For copper cable lugs) | Yes. |
| d) Thickness of tinning: | 10 microns |
| e) Applicable Standard for LT Cables | IS:8309 |

2 FERRULES:

- | | |
|------------------------|--------------|
| a) Colour of ferrules: | Yellow/White |
| b) Colour of engraving | Black |

3. TAGS:

- | | |
|---------------|--------------------------------|
| a) Material : | Al/Fiberglass/ Stainless Steel |
| b) Markings: | Engraving/Embossing/Printing |

1.14.14 APPROVED SUB-VENDORS FOR SUPPLY ITEMS (IF APPLICABLE)

S.No.		Approved Vendors
1.	Cable glands	Comet/ Electromag/ Baliga/ FCG/ Metro/ Jainson/ HMI/ Power Engineering/ Multifix
2.	Cable lugs	Dowels/ Lotus/ Jainson/ Power Engineering/ KlipOn/ Multi
3.	GI Conduits	Jindal or equivalent
4.	Flexible Conduit	PLICA
5.	Flameproof Junction Boxes/ Cable Glands	Baliga/ FCG/ Flexpro
6.	Multi pin Power Sockets	Best & Crompton/ Baliga/ Multipins/ Cuttler Hemmar (C&H), PUSHTRON (Shrenik & Co.)

Note:

1. Any other make proposed by bidder shall be subject to BHEL's approval.
2. Necessary test certificates shall be given for explosion proof cable glands

1.14.15 MANPOWER REQUIREMENT

Manpower requirement for Erection and Commissioning shall as follows:

There shall be a separate Site In-charge for C&I/ electrical/ Illumination Works, along with adequate supervisors and Technicians. Similarly commissioning Engineers also shall be identified separately for C&I Works, as indicated elsewhere in this specification.

1.14.16 DOCUMENTATION

1. The following information shall be furnished within two weeks of award of contract for purchaser's approval:

-Bar chart covering planned activities at site

-Detailed organization chart

-Details of T&P available with contractor with document proof.

2. The following information shall be furnished after testing and inspection :

Test certificates of various tests conducted at site.

3. As built drawings:

After successful completion, testing and commissioning of installation work, the above listed Purchaser's drawings/documents shall be updated in line with the actual work carried out and as built drawings/documents shall be submitted by the contractor as agreed for the project.

1.14.17 ELECTRICAL INSPECTORATE'S APPROVAL:

1. All electrical installation covered in contractor's scope are to be inspected/approved by the electrical inspector/statutory authority. For getting electrical inspector's approval, contractor shall arrange the following:

a. Completion certificate for all the equipment covered in the contract

b. Copy of Test results conducted at site for all the equipment including Electrical Equipment erected as part of Main Equipment.

c. All other documents as required by statutory authority.

d. Contractor shall carry out the modifications/rectifications if any as suggested by the authority at his cost.

2. Contractor shall also have valid electrical installation license on his company as well as for individuals acceptable to respective state electrical inspectorate requirement.

3. BHEL shall pay all other fees (FEES FOR VISITS, INSPECTION FEES, REGISTRATION FEES, etc.). However any expenditure related to documentation shall be born by contractor.

PART – I CHAPTER - XV

PROGRESS OF WORK

The scope of the work will comprise of but not limited to the following:

- 1.15.1 Refer forms F -14 to F-18 of volume I D of volume -I book-II. Plan and review will be done as per the formats.
- 1.15.2. Contractor is required to draw mutually agreed monthly erection programs in consultation with BHEL well in advance. Contractor shall ensure achievement of agreed program and shall also timely arrange additional resources considered necessary at no extra cost to BHEL.
- 1.15.3. Progress review meetings will be held at site during which actual progress during the week vis-a-vis scheduled program shall be discussed for actions to be taken for achieving targets. Contractor shall also present the program for subsequent week. The contractor shall constantly update / revise his work program to meet the overall requirement. All quality problems shall also be discussed during above review meetings. Necessary preventive and corrective action shall be discussed and decided upon in such review meetings and shall be implemented by the contractor in time bound manner so as to eliminate the cause of nonconformities.
- 1.15.4. The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials reports, consumables (gases / electrodes) report, cranes availability report and other reports as per Performa considered necessary by the Engineer as per the format enclosed with this tender document.
- 1.15.5. The contractor shall submit weekly / fortnightly / monthly statement report regarding consumption of all consumables for cost analysis purposes.
- 1.15.6. The monthly report ending on 24th of every month shall be submitted as a booklet and shall contain the following details :-
 - a) Colour Progress photographs to accompany the report should be submitted.
 - b) Erection progress in terms of tonnage, welding joints, radiography, stress relieving, etc., completed as relevant to the respective work areas against planned.
 - c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan
 - d) Category- wise man hours engaged during the previous month under the categories of fitters, welders, riggers, khalasis, grinder-men, gas-cutters, electricians, crane operations and helpers. Data will be spilt up under the work area of Boiler

- e) Consumables report giving consumption of all types of gases and electrodes during the previous month.
 - f) Availability report of cranes
 - g) Safety implementation report in the format
 - h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.
- 1.15.7. The manpower reports shall clearly indicate the manpower deployed, category wise specifying also the activities in which they are engaged.
- 1.15.8. During the course of erection, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians employed are not sufficient BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this account including all expenses together with BHEL overheads from contractor's bills.

PART - I CHAPTER- XVI
TESTING AND COMMISSIONING

The scope of the work will comprise of but not limited to the following:

1.15 TESTING,PRE-COMMISSIONING&COMMISSIONING AND POST COMMISSIONING

(All the works mentioned hereunder shall be carried out within the quoted and accepted rate)

- 1.0 Contractor to provide necessary commissioning assistance from pre-commissioning state onwards and up to continuous operation of the unit & handing over to customer.
- 2.0 The contractor shall carry out all the required tests on the equipments erected using contractor's own consumables, labour and scaffoldings.
- 3.0 It is the responsibility of the contractor to provide necessary manpower, tools, tackles and consumable within the quoted price to carry out the test of this package.
- 4.0 All required tests indicated by BHEL and their clients for successful commissioning is included in the scope of these specifications. These tests / activities may not have been listed in these specifications. All the tests should be repeated till all the equipments satisfy the requirement / obligation of BHEL to their customer. All the repairs arising out of the failures during testing shall be done by the contractor as part of the work.
- 5.0 The contractor shall carryout any other test as desired by BHEL Engineer on erected equipment covered under the scope of this contract during testing, pre-commissioning, commissioning, and operation, to demonstrate the completion of any part or whole work performed by the contractor.
- 6.0 In case, any rework is required because of contractor's faulty erection, which is noticed during pre-commissioning and commissioning, the same has to be rectified by the contractor at his cost. If any equipment / part are required to be inspected during pre-commissioning and commissioning, the contractor will dismantle / open up the equipment / part and reassemble / redo the work without any extra claim.
- 7.0 After synchronization, the commissioning activities will continue. It shall be the responsibility of the contractor to provide manpower including necessary consumables, hand tools and supervision as part commissioning assistance.

- 8.0 It shall be the responsibility of the contractor to provide various categories of workers in sufficient numbers along with Supervisors during pre commissioning, commissioning and post commissioning of equipment and attending any problem in the equipment erected by the contractor till handing over. The contractor will provide necessary consumables, T&Ps, IMTEs etc., and any other assistance required during this period. Association of BHEL's / Client's staff during above period will not absolve contractor from above responsibilities.
- 9.0 It shall be specifically noted that the contractor and employees of the contractor may have to work round the clock during the pre-commissioning, commissioning and post-commissioning period along with BHEL Engineers / customer officials. Hence contractor's quoted rate shall take into consideration of all expenses that will be incurred for such arrangement of personnel including engineers/supervisors.
- 10.0 During commissioning any improvement / repair / rework / rectification / fabrication / modification due to design improvement / requirement is involved, the same shall be carried out by the contractor promptly and expeditiously.
- 11.0 Contractor shall lay all necessary electric cables and switches etc. required for the tests and maintain the system till the tests are completed satisfactorily.
- 12.0 The contractor shall carry out the trial run of motors including checking the direction of rotation in the uncoupled condition checking aligning and coupling the motor to the respective driven equipment. Before starting the motor, IR values of insulation shall be recorded and if found necessary the contractor shall dry out to improve the IR value at no extra cost.
- 13.0 Necessary scaffolding and approaches for conducting the above shall also be within the scope of the contract.

PART- I CHAPTER-XVII

PAINTING

The scope of the work will comprise of but not limited to the following:

- 1.17.0 FINAL PAINTING
- 1.17.1 The scope of work shall also include supply and application of final painting of all the erected equipments as required and specified for the components of boiler and its auxiliaries.
- 1.17.2 In the case of steel fabricated items, raw steel after fabrication has to be cleaned and subsequent painting to be carried out.
- 1.17.3 All the exposed metal parts of the equipments including piping, structures, hangers etc., wherever applicable after installation unless otherwise specified the surface protected, are to be first painted with at least one coat of suitable primer and required number of finish coats which matches the shop primer paint used, after thoroughly cleaning the dust, rust, scales, grease oil, and other foreign materials by wire brushing scrapping and chemical cleaning and the same being inspected and approved by BHEL engineers for painting. Afterwards the above parts shall be finished with as per the instructions of BHEL/Customer official.
- 1.17.4 Paint shall be applied by brushing or by spray painting as per the instruction of BHEL Engineer. Spray painting gun and compressed air arrangement has to be made by the contractor himself. It shall be ensured that brush marks are minimum.
- 1.17.5 Before applying the subsequent coats the thickness of each coat shall be measured and recorded with BHEL / Customer.
- 1.17.6 Paint used shall be stirred frequently to keep the pigment in suspension. Paint shall be of the ready mix type in original sealed containers as packed by the paint manufacturer. No thinners shall be permitted. Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.,
- 1.17.7 The scope of painting includes application of colour bands, lettering the names of the systems equipments; tag Nos of valves, marking the directions and other data required by BHEL within the quoted rate.
- 1.17.8 All surfaces shall be thoroughly cleaned, free from scales, dirt and other foreign matter. Each coat shall be applied in an even & uniform film free from lumps, streaks, runs, sags and uncoated spots. Each coat (Primer, intermediate, finish) shall have a minimum thickness of dry film thickness (DFT) in microns and the DFT of finish paint shall not be less than the specified. Necessary instrument for measuring the thickness of paint applied is to be arranged by the contractor.
- 1.17.9 The actual colour to be applied shall be approved by the customer before starting of actual painting work.

- 1.17.10 Primer & finish paint shall be of reputed paint supplier approved by BHEL / Customer. Contractor has to procure paints from the **BHEL / Customer approved agencies** only, and the paints should be as per the customer painting specification. The quality of the finish paint shall be as per the standards of IS or equivalent as approved by BHEL / Customer. Before procurement of paint the contractor has to obtain the clearance from BHEL authorities.
- 1.17.11 No paint shall be applied when the surface temp is above 55 deg. Centigrade or below 10 deg. Centigrade, and when the humidity is greater than 90% to cause condensation on the surface or frost / foggy weather.
- 1.17.12 If needed and insisted either by BHEL / Customer in certain cases, spray painting has to be carried out within the Quoted rates.
- 1.17.13 Before commencement of final painting, contractor has to obtain written clearance from BHEL / Customer for effective completion of surface preparation.
- 1.17.14 Before applying the subsequent coats, the thickness of each coat shall be measured and recorded with BHEL/ Customer.
- 1.17.15 PRESERVATION / TOUCH UP PAINTING
- 1.17.15.1 Contractor shall carryout cleaning and preservation / touch up painting for the materials / equipments under this tender specification right from placement stage to till the equipment is cleared for final painting.
- 1.17.15.2 The contractor shall effectively protect the finished work from action of weather and from damage or defacement and shall cover the finished parts, then and there, for their protection.
- 1.17.15.3 Any equipment which has been given the shop coat of primer shall be carefully examined after its erection in the field and shall be treated with touch up coat of red oxide primer wherever the shop coat has been abraded, removed or damaged during transit / erection, or defaced during welding.

ANNEXURE -1

RECOMMENDED LIST OF TOOLS & PLANTS REQUIRED FOR ELECTRICAL/ C&I WORKS

S.NO	DESCRIPTION
01	Steel wire ropes
02	Chain pulley block/turfer
03	2 " size pipe bending machine
04	Grinding machine
05	Drilling machines : 1/4" , 1/2" , 3/4" , 1 "
06	Copper tube bender and cutter sizes 6 mm ;8 mm ;1/2",1/4"
07	Dye sets for threading upto 2 " pipe
08	Set of spanners
09	Allenkey sets
10	Bench vice
11.	Spirit level
4	Tap sets for both BSP & NPT threads upto 1 "
13	Measuring instruments like micrometers, calipers etc.
14	Welding generator
15	Welding transformer
16	TIG Welding set
17	Mechanical tool kit for fitters
18	Electrician tool kit
19	Crimping tool
20	Flood light fittings
21	Fire extinguishers
22	Distribution boards with power cable complete as required
23	Hydraulic test pump rating 750 Kg/SQ.cm
24	Painting brush
25	Fire proof tarpaulin
26	Safety belts & safety helmets
27	Telephone sets

ANNEXURE - 2

ACCURACY REQUIREMENT OF TESTING INSTRUMENTS

SI. No	INSTRUMENT / TOOL	RANGE	ACCURACY
1	Power Pack	0 to 50V DC, 3A	$\pm 2\%$
2	Analog Multimeter	Voltage 2.5 to 2500V AC	$\pm 1.0\%$
		Current 100 mA to 10A AC	$\pm 2.0\%$
		Current 250 micro A to 1A DC	$\pm 1.5\%$
		Resistance upto 100 ohms	$\pm 3.0\%$
		Voltage 2.5V to 2500V DC	$\pm 1\%$
3	Digital Multimeter	Voltage 200mV to 1000 V DC	$\pm 1\%$ + 1 digit
		Philips Voltage 200mV to 1000 V AC	$\pm 1\%$ + 1 digit
		Hcl Current 200mA to 20 A AC	$\pm 0.8\%$ + 1 digit
		Philips Current 20 mA to 20 A AC	$\pm 0.8\%$ + 1 digit
		Resistance (Hcl) 240 200* to 200M*	$\pm 0.5\%$ + 1 digit
		Resistance (Hcl) 2105 200* to 200M*	$\pm 0.25\%$ + 1 digit
		Hcl Voltage 200mA to 750 V	$\pm 0.8\%$ + 1 digit
		Philips Current 20 mA to 20 A DC	$\pm 0.5\%$ + 1 digit
		Hcl Current 200 mA to 010 A AC	$\pm 1\%$ + 1 digit
4	Vibration Measuring Equipments	Velocity upto 50 mm/sec.	$\pm 0.5\%$ mm/sec
		Displacement upto 300 microns	± 2 microns
5	Secondary Injection Kit	Upto 5A	$\pm 0.5\text{mA}$
6	Motor operated Megger	Upto 200 Ohms	$\pm 5\%$ at Centre scale
7	Tongue tester	0/300/600A AC	$\pm 5\%$
		0 to 300A DC	$\pm 5\%$
8	Tachometer (Hand held)	0 to 4000 rpm	$\pm 5\%$
9	Phase Sequence		N/A

SI. No	INSTRUMENT / TOOL	RANGE	ACCURACY
	Meter		
10	Three Phase Variac	15 A Capacity	N/A
11	Feeler gauges	300 mm long and 100 mm long	± 2 microns
4	Dial gauges	Q	± 0.01 mm
13	Hand operated Megger 500 V / 1000V	Upto 200 M Ohms	$\pm 5\%$ at Centre Scale $\pm 10\%$ at end of Scale
14	Motorised Megger 2.5 KV	Upto 200 M Ohms	$\pm 5\%$ at Centre Scale $\pm 10\%$ at end of Scale
15	Earth Megger (Tester)	0 to 1, 10, 100 Ohms	$\pm 5\%$ at Centre Scale range
16	AC tongue Tester	0 to 300A AC	$\pm 3\%$
17	DC Tongue Tester	0 to 300A DC	$\pm 5\%$
18	High Voltage test Kit	Upto 50 KV AC Upto 70 KV DC	$\pm 10\%$ $\pm 10\%$
19	Tacho Generator (Mech)	0 to 4000 rpm	$\pm 0.25\%$
20	DC Ammeter	0 to 300 A	$\pm 10\%$
21	DC Voltmeter	0 to 500 V	$\pm 10\%$

OTHER REQUIREMENTS OF CONTRACTOR'S INSTRUMENTS & T&P

- a. The contractor shall arrange all the above T&P, equipment and instruments as indicated except testing instruments which are proprietary in nature.
- b. Any other tools and plants instruments and equipment required in addition to the above other than propriety type T&P/Instruments for the successful completion of this job shall be arranged by the contractor at his cost.
- d. Necessary accessories for the above shall also be provided by the contractor.
- e. The above instruments/equipment shall be sent for testing and calibration wherever from time to time and maintained by contractor as required by BHEL.

- f. List of such agencies and periodicity of calibration required for different instruments shall be furnished by BHEL at site.
- i. Contractors shall arrange experienced/qualified persons for using these calibration instruments at laboratory and also at work spot.
- j. Wherever frequent calibration is required, contractor shall arrange adequate number of instruments such that the work does not suffer for want of test instruments.

NOTE

01. Minimum Number of persons to be indicated monthwise.
02. Above deployment plan shall be discussed with BHEL Site Engineer and necessary changes shall have to be made by the contractor as per discussion. If required, any additional deployment during execution of the work shall have to be arranged by the contractor for meeting various schedules/targets set by BHEL without any additional compensation.
03. Resident Engineer should have a minimum qualification of Engineering Degree or Diploma in Engineering with 15 years of experience in Thermal Power Station.
04. Supervisor should have a minimum qualification of Diploma in Engineering or a graduate with 10 to 15 years of experience in Thermal Power Station.
05. Lab Technicians should have experience in Thermal Power Stations.
06. Contractor should have one Store Keeper and one Transport Supervisor for the safe transportation of materials.

ANNEXURE - 4

DEPLOYMENT PLAN FOR MAJOR TOOLS AND PLANTS / INSTRUMENTS

S.NO	CATEGORY	MONTHS	PRESENT LOCATION
		1 2 3 4 5 6 & SO ON	
01	Welding Generators		
02	Welding Transformer		
03	TIG Welding sets (air cooled)		
04	Insulation Tester a. Motorized Megger 1000 & 5000 V Grade b. Hand operated Megger 500 & 1000 V Grade		
05	Earth resistance Megger		
06	Transformer oil testing kit		
07	Torque wrench		
08	Volt Meter/Ammeter/ Avometer/other instrument		
09	Multimeter/Test lamps/ Field telephone sets/ different gauges		
10	High vac steam line filter of 6000/4500 LPHfor transformer dryout		

S.NO	CATEGORY	MONTHS	PRESENT
		1 2 3 4 5 6 & SO ON	LOCATION
11	3 phase/Single phase Variac 15 Amps		
4	Primary and Secondary Injection testing kits.		
13	HV test kit		
14	Resistance measurement unit		
15	Oscilloscope		
16	5 Amps DC Power Supply unit		
17	Crimping Tools with various sizes of dyes.		

NOTE

01. The list of Tools and other plants to be deployed for this project may be indicated by the tenderers separately.
02. Above deployment plan shall be discussed with the site engineer and necessary changes shall have to be made by the contractor as per discussions. If required, an additional deployment during execution of work shall have to be made by the contractor for meeting various schedules/targets set by BHEL without any additional compensation.

ANNEXURE - 5

BHEL PS:SR Format No.

CP: PEX:FOX

CALIBRATION RECORD OF SUB-CONTRACTOR'S INSTRUMENTS

Name of Site :

Name of Sub-contractor:

Sl.No	NAME OF INSTRUMENT	INSTRUMENT REGN. NO.	DATE OF	PERIODICITY OF CALIBRATION	CALIBRATION DETAILS
			ENTRY EXIT		
					DATE OF CAL. CAL. AGENCY NEXT DUE DATE DATE OF CAL. CAL. AGENCY NEXT DUE DATE DATE OF CAL. CAL. AGENCY NEXT DUE DATE

SIGN OF SITE CIC

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PART – II CHAPTER – 1

REVERSE AUCTION PROCEDURE

GENERAL TERMS AND CONDITIONS OF REVERSE AUCTION

Against this NIT for the subject work, tender shall be processed through “REVERSE AUCTION PROCEDURE” i.e. ON LINE BIDDING on INTERNET.

1. For the proposed reverse auction, technically and commercially acceptable bidders only shall be eligible to participate.
2. BHEL will engage the services of a service provider who will provide all necessary training and assistance before commencement of on line bidding on Internet.
3. BHEL will inform the vendor in writing in case reverse auction, the details of service provider to enable them to contact and get trained.
4. Business rules like event date, time, start price, bid decrement, extensions, etc. also will be communicated through service provider for compliance.
5. Vendors have to fax the compliance form in the prescribed (provided by service provider) before start of Reverse auction. Without this the vendor will not be eligible to participate in the event.
6. BHEL will provide the calculation sheet (e.g.: EXCEL sheet) which will help to arrive at “Total Cost to BHEL”.
7. Reverse auction will be conducted on schedule date & time.
8. At the end of reverse auction event, the lowest bidder value will be known on the network.
9. The lowest bidder has to fax the duly signed filled-in prescribed format as provided on case-to-case basis to BHEL through service provider within 24 hours of action without fail.
10. During Reverse Auction, the process of reverse auction is unsuccessful then BHEL at its discretion may decide to call the L1 bidder of reverse auction for further negotiation.
11. Sealed bid reverse auction: The opening bid (in the initial auction) of the bidders shall be same as that quoted in their final sealed price submitted to BHEL. The bidder shall confirm in writing to BHEL that their opening bid in both cases shall be same as that quoted in their final sealed price bids submitted to BHEL against this NIT along with Technical bid.
12. BHEL reserves the right to cancel Reverse Auction (RA) without assigning any reasons and resort to considering the sealed bids submitted by vendor for processing and finalizing the tender.

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13. Any variation between the on-line bid value and signed document will be considered as sabotaging the tender process and will invite disqualification of vender to conduct business with BHEL as per prevailing procedure.
14. In case BHEL decides not to go for Reverse auction procedure for this tender enquiry, the price bids and price impacts, if any already submitted and available with BHEL shall be opened as per BHEL standard practice.
15. Bids given by the bidders during the reverse auction process will be taken as an offer to execute the work. Bids once made by the bidder, cannot be cancelled/withdrawn and bidders shall be bound to execute the work as mentioned above at the final bid price. BHEL shall take appropriate action as the lowest bidder do not execute the contract as per the rates quoted by him.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PART II CHAPTER-II

CPCL MANALI PHASE –III

1X20 MW CO-GEN PLANT, CHENNAI

ELECTRICAL/ C&I/ ILLUMINATION PACKAGES

GENERAL TECHNICAL REQUIREMENTS AND GUIDELINES FOR INSTALLATION, TESTING, COMMISSIONING AND SUPPLY ITEMS

2.2.0 INSPECTION & TESTING IN GENERAL:

The stages of completion of various works shall be as follows :

- Equipment shall be considered to be completely erected when the following activities have been completed.
- Moving of all equipments to the respective foundations.
- Fixing of anchor bolts or tack welding as required.
- Levelling and alignment of equipment.
- Assembling of all accessories such as relays, CTs, PTs, meters, instruments etc. as described in the job specification.
- Drying of equipment as required and testing of oil for di-electric strength.
- Filtration and filling of oil as required.
- Cable laying, termination with continuity check.
- Applying of finishing coat of paint.
- Mounting of lighting fixtures and connections.
- Completion of earthing system.

All the equipment shall be tested at site to know their condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by contractor are detailed below.

The contractor shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.1 SITE TESTS AND CHECKS

a)General

All the equipments shall be tested at site to know their condition and to prove suitability for required performance.

The test indicated in following pages shall be conducted after installation. All tools, accessories and required instruments shall have to be arranged by contractor. Any other test which is considered necessary by the manufacturer of the equipment, contractor or mentioned in commissioning manual has to be conducted at site.

In addition to tests on individual equipment some tests/checks are to be conducted/observed from overall system point of view. Such checks are highlighted under miscellaneous tests but these shall not be limited to as indicated and shall be finalised with consultation of client before charging of the system.

The contractor shall be responsible for satisfactory working of complete integrated system and guaranteed performance.

All checks and tests shall be conducted in the presence of client's representative and test results shall be submitted in six copies to client and one copy to Electrical Inspector. Test results shall be filled in proper proforma.

After clearance from engineer in-charge system/ equipment Completion shall be charged in step by step method.

Based on the test results clear cut observation shall be indicated by testing engineer with regard to suitability for charging of the equipment or reasons for not charging are to be brought by the contractor.

b)Trial Run Test

After the successful test of each equipment as per standard test procedure the entire control system shall be put on trial run test on actual site conditions and operation of the system.

c)Acceptance Test

The acceptance test on the system shall be carried out by the supplier as per mutually agreed test procedures to establish satisfactorily

TECHNICAL CONDITIONS OF CONTRACT (TCC)

functioning of the System as a whole and each equipment as part of the system.

2.2.2 TRANSFORMER

2.2.2.1 INSTALLATION

To ensure that a transformer will function satisfactorily, it is important that handling, lifting, storing and assembling are carried out with great care and cleanliness by experienced personnel who knows the various working operations very well.

2.2.2.2 INSPECTION

In connection with receiving and unloading at site, and at the final storing place before assembling, the transformers shall be inspected carefully. External visible damages as dents, paint damage etc. may imply that the transformer has been subjected to careless handling during transport and/or re-loading, and a careful investigation is therefore justified.

After the arrival of the material at receiving points, before unloading, the condition of packing and of the visible parts should be checked and possible traces of leaks verified (condenser bushing). If necessary, appropriate statements and claims should be made.

Drums containing oil which have despatched separately should be examined carefully for leaks or any sign of tampering,. All drums are despatched filled upto their capacity and any shortage should be reported.

Check immediately the gas pressure at the arrival. A positive pressure indicates that the tank and the transformer components respectively are tight, and that the active part including the insulation materials are dry.

If there is no positive gas-pressure, transformer should be immediately filled with dry Nitrogen gas at a pressure of 0.17 kg/Cm² (2.5 psi) without loss of time.

Otherwise, it should be checked if the core isolation is satisfactory and that accessories packed separately have not been damaged during transportation .

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2.2.2.3 UNLOADING

Whenever rollers/trolleys are supplied with transformer, movement of transformer at site is carried out by mounting these rollers/trolleys.

Alternatively for movement of transformer from loading bay to actual site of the equipment, skidding on greased rails etc. can also be resorted to.

2.2.2.4 STORING

Dismantled equipment and components are packed to the protected against normal handling and transport stresses. The instructions for lifting given on the packages, must be complied with to avoid damages.

Goods stored outdoors must not be placed directly on the ground, and should be covered carefully with tarpaulin or similar materials.

Oil drum should be stored in horizontal (lying) position with both the bungs also in horizontal position.

2.2.2.5 LIFTING

Lifting devices on the transformer tank are dimensioned of lifting of the complete transformer filled with oil. The positioning of the lifting devices, permissible lifting angles, minimum height to crane hook and transformer weight, appear from the OGA drawings. Check at lifting of complete transformer that the lifting wires/ropes are not in contact with bushing or other components on the cover.

For lifting with hydraulic jacks, the transformer is provided with jacking pads dimensioned for lifting of complete transformer filled with oil. The position of the pads appear on the OGA drawings.

2.2.2.6 CHECK POINTS BEFORE STARTING AND DURING ERECTION

a. Check points before starting erection.

1. Conditions of leads
2. Bracing, clamping of leads
3. Connections
4. Tapchanger checks
5. General conditions of insulation

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6. Core check that it has not moved in transit.
7. Core-ground; this is checked with the megger after removing earth connection
8. CTs, including the secondary leads and their passage through metal parts
9. Check that shipping frame for bushings have been removed.
10. Check that coil position has not moved in transit
11. Check for dirt, metal swarf, moisture
4. Check that the bushing leads set without being too close to ground or other points of different potential.

b. Check-points during erection:

By means of the part list and the transformer/reactor OGA, the assembling of a fully completed transformer is carried out according to the following instructions. The following precautions are to be taken:

1. Fire-fighting equipment shall be available at the oil-treatment equipment as well as at work on and adjacent to the transformer.
2. Welding work on or adjacent to the transformer shall be avoided, but if this is not possible, the work shall be supervised by fire-protection personnel.
3. Smoking on or near the transformer shall not be allowed.
4. Transformer tank, control cabinet etc, as well as assembling and oil-treatment equipment shall be connected with the permanent earthing system of the station
5. Check that there is no overpressure in the transformer when blanking plates or connection lids are to be opened.
6. All loose objects, tools, screws, nuts etc.. shall be removed from the transformer cover before opening the connection and blanking lids.
7. All loose objects (tools, pencils, spectacles etc..) shall be removed from the boiler- suit pockets etc. before starting the work through man holes.

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8. Tools to be used inside the transformer e.g. for tightening of screws-joint-shall be fastened to the wrist or another fixed point by means of cotton tape or string.
9. Tools with loose sleeves and tools with catches must not be used at work inside the transformer.
10. Greatest possible cleanliness shall be observed at work inside the transformer, and at handling of part to be mounted inside the transformer.
11. Fibrous cleaning materials should not be used as it can deteriorate oil when mixed with it.
12. All components despatched separately should be cleaned inside and outside before being fitted.
13. A Transformer is best protected from damp hazard by circulating warm, dry, de-aerated oil through it until its temperature is 5 C to 10 C above ambient. This should be done before allowing external oil to the interior of the tank. The warm oil should be circulated all the time transformer is open to atmosphere.
14. Oil pump & all joints in the oil pipe work should be air tight to avoid entrance of air through leakage joints.
15. The active part (core and winding) should be exposed to the surrounding air as short time as possible. Open therefore only one blanking plate or connection lid at a time for remounting of bushing, valves etc.
16. Objects which-despite all precaution are dropped inside the transformer, must absolutely be brought out from the equipment.
17. Check that the oxygen content inside the transformer tank is minimum 20% if a person is to enter the tank.

2.2.2.7 ASSEMBLY

Assembly of wheels Bushing Valves, cooling device, Oil conservator, Pipe Flanges, Blanking plates and accessories like cooling fans, pumps, OLTC and components for supervision and control oil level indicator, flow indicators, gauges, Bucholz relay, PRV, thermometers etc. are assembled according to leaflet/ description valid for the components.

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2.2.2.8 OIL FILLING

The following procedure is recommended.

- (i) Close and blank the valve to isolate the conservator from main tank. Fill the oil in transformer under vacuum upto Bucholz level as per instructions given elsewhere.
- (ii) After filling the oil in transformer and breaking the vacuum, oil can be filled in the conservator by drain valve.
- (iii) Remove the inspection cover (ii) provided on the side of the conservator and check the air cell assuring that it is inflated. The air cell must remain in fully inflated condition during oil filling operation. If the air cell is found deflated fit the inspection cover and inflate the air cell with dry air/nitrogen gas to 0.035 kg/sq.cm max. A gauge may be put by removing plug. After filling close these connections.
- (iv) Remove air release plugs provided on top of the conservator.
- (v) Slowly pump the oil through drain valve . Temporarily stop filling operation when oil starts coming from opening after ensuring that no air bubbles come out through these air release holes. Fit the two air release plugs.
- (vi) Continue oil filling till oil start coming from air release plug stop oil after ensuring that no air bubbles come out. Fit the plug .
- (vii) Now release the air pressure held inside the air cell from point and continue oil filling until magnetic oil gauge indicates 35 deg.C level.
- (viii) Remove oil pump and connect air cell to breather from point. Also remove pressure gauge and put plug.
- (ix) Conservator tank shall be filled up with oil as per the supplier's instructions.
- (x) The system is now properly filled. Air release plugs are fitted in normal operation.

2.2.2.9 EQUIPMENT FOR OIL-FILLING UNDER VACUUM

- (i) High-vacuum 2 storage oil filtration plant provided with thermostat-controlled oil heaters and vacuum-proof hoses with

TECHNICAL CONDITIONS OF CONTRACT (TCC)

dependent vacuum pumping system for tank evacuation.
Capacity: 6000 lph

- (ii) Oil-storage tanks provided with silica-gel breathers and inlet/outlet valves for oil circulation. Recommended capacity 20KL
- (iii) Vacuum gauges provided in filtration plant.
- (iv) Equipment for measurement of electric strength (BDV) of oil - 100 kv set.
- (v) Equipment for moisture content of oil.
- (vi) Equipment for measurement of Resistivity and Tan delta at 90 C.
- (vii) Transparent vacuum-proof tubes for checking of oil-level during oil filling.
- (viii) Valves, fitting, gaskets etc.
- (ix) Dry nitrogen cylinders.

2.2.2.10 COMMISSIONING

Testing after Assembly of the Transformer

After the transformer/has been assembled at site, it shall be tested in order to check that it has not been damaged during transport and assembly to such an extent that its future operation will be at risk. Regarding the performance of the test, refer to the testing method as per standards. The results of the test shall be documented.

COMMISSIONING CHECKS

SL NODE DESCRIPTION

1. Breather Silica gel (Blue when dry)
2. Oil in the Breather housing cup.
3. All valves for their correct opening and closing sequence.
4. Oil level in conservator tank.
5. Oil in cooling system.
6. Oil level in bushings.
7. Release air, wherever necessary.

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8. Cooling accessories (Pump motors, Fan motors etc.) for direction and O/L setting.
9. Buchholz, oil level indicator, pressure gauges, thermometer, Temp. indicators etc.
10. Neutral earthing.
11. Earth Resistance of Electrodes.
12. Earthing of bushing test tap.
13. Check oil leakage for 24 hrs.
14. Check Auxiliary circuit voltage (415 V)
15. Calibration of OTI/WTI with hot oil.
16. Check Working of WTI/RTD repeaters at control room.
17. IR of core to earth.
18. Die electric strength of oil PPM & Chemical analysis test
19. IR tests on windings to earth and between winding
20. Phase sequence test & vector group check
21. Continuity test
22. No load voltage ratio on all tap position
23. Winding resistance in all taps
24. Local and remote operation of tap changer
25. TAN-DELTA test if quality check list calls for.

INSULATION RESISTANCE TEST

Sl.No	Description	Date	Time in Hrs	Megger (not IR	Value	Temp
	Remarks					
	less than 500 V)					
1.	Control wiring					
2.	Tap Changer					
	a) Motor					
	b) Control					
3.	Cooling system					

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- a) Motor Fan
 - b) Motor pump
 - c) Control Wiring
4. Main Winding
- a) HV/E+:VNot less than 1000 V megger)
 - c) LV/E+HV+LV
 - d) HV/IV
 - e) IV/LV
 - f) HV/L

Note

(1) While checking these values no external, lighting arrestors etc should be in circuit.

(2)Special care should always be taken while meggering the transformer winding to ensure that there is no leakage in the leads.

Oil Characteristics.

Take necessary precaution (regarding rinsing the bottle, cleaning hand, air bubble etc) while withdrawing the samples, Each sample should be free of air bubbles and should not be tested when it is hot. The sample should satisfy IS:1866.

- 1.Tank Top Sample Bottom Sample
- 2.Cooling system Top Sample Bottom Sample
- 3.OLTCDivertor (each phase)

Tests on CT

- 1.. Ratio
2. Polarity
3. Magnetising current
4. IR Value

Potential Transformer Tests

1. IR test of primary winding by HV megger between windings

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2. IR test of secondary winding by LV megger between winding and winding to earth
3. Checking of voltage ratio
4. Verification of terminal markings and polarity
5. Checking of oil level if applicable
6. Checking of continuity and IR values for cables from PT to M
7. Checking tightness of earthing connection.
8. Checking of insulator for cracks
9. Checking output on charging of the system with connected meter

On Load Tap changer

Sl.No	Description	Date	Observation	Remarks
1.	Visual Inspection of equipment.			
2.	Hand operation on II taps.			
3.	Complete wiring of the circuits.			
4.	Limit Switch			
5.	Over running device			
6.	Remote Panel Wiring.			
7.	Overload Device of Driving Motor.			
8.	Local Operation (Electrical)			
9.	Remote Operation (Electrical)			
10.	Tap Position Indicator.			
11.	Step by step contractor			
4.	Out of Step Relay.			

Note

- 1) While operating the mechanism on Electrical Control, check once again limit switches, step by step contractor, over running device etc. for their actual operation and prove that they are functioning properly.
- 2) For More details Please refer Respective Manuals.

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2.2.3 BUSDUCTS - SEGREGATED PHASE

HANDLING AND STORAGE

2.2.3.1 General

Busduct form the main electrical connections between the Generator and associated generator transformer and tap-off to PTSP cubicle. The ducts are made of aluminium sheet which house the busbar conductors supported on post insulators. The duct assembled are suitably supported on the structures in the station. The bus enclosure assembled are despatched with the insulators assembled and the conductor are sent either loose or assembled inside the duct, keeping in view the erection necessities and transport limitations.

2.2.3.2 Inspection at Site :

When the packages are received at site, these must be checked for the following:

- a. Completeness and correctness of the consignment. (Compare with delivery documents)
- b. Physical damage if any during transit.

2.2.3.3 Handling During Erection :

The busducts are in unpacked conditions, therefore, great care is necessary in handling. Ensure that :

- a. While lifting enclosure assemblies manila ropes are passed round the busduct enclosure near the support channels.
- b. All shipping steel clamps are to be tightened and busbars do not slip out while handling, if the busbar is assembled in the enclosure.
- c. While inserting and mounting the busbar in the enclosure care is taken that the busbar does not hit and damage the insulators.
- d. Eye bolts are used while lifting the cubicles.

2.2.3.4 Caution

1. When inspecting the enclosures assemblies etc. the wooden packings, braces and polythene covers should be replaced, if removed, to prevent damage and ingress of duct and moisture.

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2. Aluminium being softer material, great care must be taken in handling enclosures and other aluminum items.
3. If the site conditions make it impossible to return the items to the cases for storage:
 - a. Nothing must be laid direct on the ground.
 - b. All items must be protected against weather and damages.

2.2.3.5 HANDLING OF BUS DUCT.

Handling from delivery station to power station stores :

1. Use suitable slings to lift the packages
2. No impact should come on the packings while loading. Do not drop from height.
3. Do not stack busduct packings one above the other; also avoid stacking of heavier items on busduct packings.

2.2.3.6 During unpacking, handling and storage

DOs

1. Check all the packings for any damage during transit.
2. Open the packings carefully.
3. Verify material as per shipping list and report any shortage/ damage immediately.
4. Keep material in original packings unless required for erection.
5. Ensure that Manila ropes are used for lifting the busduct.
6. Check the tightness of shipping steel clamps while lifting busduct assembly with busbar in position.
7. Ensure that CTs, LAs, capacitors, N.G. transformer, grounding resistor, fuses, insulators, wall bushings, moulded and rubber items and flexibles are stored in well ventilated area.

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DON'Ts

1. Don't destroy any markings.
2. Don't drop packings from height.
3. Don't stack heavier items on busduct packings.
4. Don't keep door of cubicle open during storage.
5. Don't lay down unpacked material directly on the ground.
8. Don't cause damage or scratches by dropping, dragging etc. on fragile items such as CTs, PTs, Insulators, rubber items etc.

2.2.3.7 During Erection & Commissioning:

DOs

1. Carry out pre-lay survey to verify the position of various equipments to be connected, levels of floors and positions of cut-outs.
2. Keep the layout drawing etc. ready for reference.
3. Draw the material from stores as per erection sequence.
4. Ensure alignment and proper matching of various enclosures and busbars.
5. Ensure proper alignments of epoxy cast CTs and seal-off bushings before final tightening of hardware.
6. Make the busbar joints as per the instructions.
7. Take care for proper sealing while joining the enclosure.
8. Ensure proper earthing of enclosure and structure as specified.
9. Check wiring as per relevant wiring diagram.
10. Ensure that CT secondaries are shorted and grounded before HV test busduct.

DON'Ts

1. Don't allow accumulation of dirt or foreign material inside the enclosure during erection.
2. Don't overtighten the bolts.
3. Don't hammer the bolts etc. while joining the busbars if holes are not matching.

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4. Don't forget any foreign material inside the enclosure.
5. Don't subject IAS, capacitors, and PTs to HT test as these are pretested and test at site is not required.
6. Don't subject NG transformers to over voltage as these are pretested.
7. Don't apply rated voltage unless pre commissioning checks are completed.

2.2.3.8 Erection Instructions

A.Packing and Shipping

Layout drawing and main bill of material (M.B.O.M) or shipping list should be referred to for identification of various items. All the drawings necessary for assembly and erection are furnished separately.

Busducts are usually despatched as single phase assemblies generally assembled with busbars. The busbars are braced with steel clamps to avoid any damage to insulators and displacement of busbars during transport. Structures, hardware, flexibles, and other miscellaneous items are packed separately.

B.Marking :

Following markings are done with paint on busduct assemblies and cubicles for identification :

1. Project name and unit number
2. Item no of main BOM this is encircled
3. Phase marking R, Y or B
4. Work order number
5. Drawing number and item/variant number
6. Arrow indicating direction towards switchgears. Direction of arrow shall be decided from lay out.

C. Similarly loose items are also identified by suitable marking on tags.

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2.2.3.9 Pre Layout Survey

Before starting the erection work the centre lines of the complete busduct installation, location of connected equipments such as switchgear, unit auxiliary transformer, LA & VT cubicle, NG Cubicle etc. with respect to generator central line should be established and marked clearly. The various levels of floor, ceiling, terminal position of main transformer, unit auxiliary transformer etc. should also be verified. Any deviations in this regard should be recorded and necessary remedial measures should be taken. In case of any substantial deviation which may effect the erection of busduct installation, the same should be referred to the design engineer. The remedial measures should be planned in advance, which may consist of levelling by suitable packers chipping of the concrete floor or wall etc. or rectification of the components with the concurrence of engineers.

2.2.3.10 Provision of foundation bolts & embedded item

In the power station, busduct is supported on various floors, halls, ceiling, etc. and support structure is suitably attached to the building. For this foundation bolts, embedded items are grouted on the number of locations as per foundation drawing.

2.2.3.11 Sequence of erection

Normally the following sequence of erection is recommended.

A. Erection of steel work :

First, all the vertical structures are to be installed, levelled and foundation bolts grouted.

Next place all the longitudinal cross channels in position, adjust the level and bolt/weld them.

Check up the correctness of levels and positions of various installed structures. For installation of foundation bolts refer foundation details drawing of the project.

B. Erection of Enclosures :

Before the installation of enclosures in position each assembly of enclosure and conductor complete with insulator supports is to be checked for correctness and cleaned on the working floor.

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The various enclosures assembled are to be erected as per layout drawing. After placing the assemblies in position the packing braces/steel clamps inside the ducts are to be removed.

Some of the busduct assemblies will be self supporting only when they are welded to adjacent enclosures, as such some temporary scaffolding is necessary to support these enclosures during erection, levelling and welding.

C.Handling of Busducts :

For handling of busducts specified instructions should be followed.

D.Sequence of erection-enclosure assemblies :

In positioning the various enclosures assemblies the following sequence is recommended :

E.Indoor Portion :

(a)Neutral Side

Complete the assembly of top chamber/neutral shorting chamber at the working floor as per the drawing. Connect copper flexibles on the generator neutral terminals, and fix it with the generator plate. Provide temporary support as necessary. Complete the assembly of bottom chamber (if applicable) along with CTs and wiring as per drawing at the working floor and match with the top chamber (if applicable). Now fix the supporting structure.

Assemble N.G. Transformer and N.G. Reactor and complete the terminal connections.

Note : Before fixing top chamber / bottom chamber, care should be taken that shunts are welded on line side busduct as shown in lay out drawing :

(b)Line Side

Assemble copper flexibles and connections with generator line terminals. Match each phase generator enclosure with generator plate and fix to the support structure. Complete the generator terminal bolted connections.

Place P.T cubicle in position match and connect with the respective tap off.

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(c) Busbar Joints :

Busbar joints may be bolted type or welded type as specified for the installation. For making the busbar joints, it is essential that specified procedures and precautions are followed.

(c) Cleaning of Busduct

Before putting the split covers, enclosures make up pieces (welded to enclosure) & covers of inspection windows, all the insulator should be cleaned again. The busduct should also be cleaned and dried up for any moisture/condensates. Thoroughly check the interior of every enclosures and ensure that these are free from any foreign matter.

(e) Inspection of windows, covers, etc.

Finally, the split covers, inspection windows and make-up piece may be assembled. The assembly of split cover, inspection windows and make-up pieces should be done as per recommended procedures and if should be ensured that proper sealing is achieved.

2.2.3.12 Busbar Bolted Joints

A. Aluminium to Aluminium Joints (Unplated)

Wipe the contact surfaces with dry clean cloth to remove any dirt, dust and moisture and smear these with recommended jointing compound. Clean the surfaces under the compound by breading with dry coarse emery cloth or stainless steel wire brush. Wipe the surfaces with a clean dry cloth and immediately make a light application of jointing compound. Close up the joints and wipe off excess compound.

B. Aluminium to Copper Joints :

Cleaning of Aluminium surface (Unplated)

Follow Instructions given and apply jointing compound.

Cleaning of copper surfaces (unplated)

Clean the copper contact surface with emery cloth and wipe the surface with clean dry cloth.

Cleaning of copper aluminium surfaces (unplated)

Clean the contact surface with dry cloth to remove dirt, dust and moisture. Apply a light coating of jointing compound.

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C. Aluminium to Copper Joints using bimetallic strip

For cleaning of aluminium and copper surfaces follow instructions given and apply jointing compound to aluminium and copper surfaces.

The contact faces of bimetallic strip should also be cleaned as per the above practice and jointing compound applied.

Note : Bimetallic strip is inserted between the copper and aluminium surfaces. Care should be taken that copper faces copper surface and aluminium faces aluminium surface.

D. Cleaning of copper surfaces (plated)

Clean the contact surface with dry cloth to remove dirt, dust and moisture.

Note : Wire, brush, emery cloth or jointing compound containing metallic particles or other abrasives should not be used on plated surfaces.

2.2.3.13 Contact pressure

To obtain correct tightening pressure on contact surfaces following torques are recommended for various bolt sizes.

Bolt Size	Recommended Torque	Torque Spanner Capacity
M10	0.85 to 1.3 NM (20-30 Ft-lb)	0.85 to 1.3 NM (20-30 Ft-lb)
M4	1.3 NM to 1.7 NM (30-40 Ft-lb)	0.85 to 4.3 NM (20-100 Ft-lb)
M16	1.7 to 2.1 NM (40-50 Ft-lb)	0.85 to 4.3 NM (20-100 Ft-lb)
M20	2.1 to 2.5 NM (50-60 Ft-lb)	0.85 to 4.3 NM (20-100 Ft-lb)

Alternatively tighten the nut till belleville washer becomes flat. Then unscrew the nut by about 1/8 th. turn.

2.2.3.14 Welded Joints of Shunts

Various locations of shunts to be welded to the enclosures are shown in layout drawing.

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2.2.3.15 Drain valve welding (if applicable)

Mark the location as per lay out and drill 10 mm dia. hole at the bottom most point of enclosure. Tack weld the drain valve pad to enclosure ensuring proper alignment of paid hole with enclosure hole. Weld continuously as per jointing recommendations. Clean with wire brush and point for final finish.

2.2.3.16 Fixing of Neoprene Seal :

Enclosures are fitted with access covers. Each cover is fitted with four pieces of neoprene seal and held in position by bolted clamps.

(Note : Only one cover should be removed from enclosure at any time to minimise the air flow into the enclosure).

2.2.3.17 Earthing of Segregated phase busduct and cubicles

A.General

One end of the electrical continuous enclosure should be earthed to station earth at the shunt location where all the three enclosures are shorted. Location of earth points are shown in the layout drawing. For this purpose two drillings are to be done on these shunt to suit at site and two separate earth strap are to be connected to the station earth thus ensuring double earthing.

In some assemblies (such as transformer hood etc) due to short length of enclosures shunts are not provided. In such cases, each phase enclosure should be separately earthed.

One point of the earth phase split cover, rubber bellow clamping strap should be electrically connected to enclosures and in turn enclosures should be earthed.

B.Cubicle earthing :

Each cubicle is provided with two number of earthing terminals. These terminals are generally located on side face of the cubicle. Both the terminals are to be connected independently to the station earth by suitable connectors.

For earthing the top and bottom C.T. chambers, station earth can be connected to each chambers of two locations for double earthing.

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2.2.3.18 Site tests on Segregated phase busduct

A. Physical Checks:

Design survey which include dimensional checking of electrical clearances and cleanliness of the installation.

B. Cleanliness :

The inside of all enclosures, outside of conductors and insulators should be free from dirt, oil, grease and any other deposits. Special attention should be paid to the insulators and seal off bushings and oil moisture is to be removed and surfaces polished with a dry soft cloth. All panels/inspection windows cover are to be replaced after cleaning operation.

C. Power Frequency High Voltage Test

Preparation :

Following equipment must be disconnected from busbars removing the bolted link and grounded suitably prior to conducting this test :

- a. Generator terminals
- b. Unit auxiliary transformer terminals
- c. Generator transformer terminals
- d. Neutral grounding transformer HV terminal
- e. Lightning arrestors
- f. Capacitors
- g. Potential transformer.

It is important to ensure that secondaries of all the current transformers mounted on busbars are shorted and grounded properly before conducting this test.

Ensure that all insulators seal-off bushings are cleaned free from any dust, grease and moisture etc. before test.

During the test, ensure the following

- a. The generator rotor is kept stationary
- b. H.V. Circuit breakers on system side are kept in the open position.

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D. Test Voltage :

The test voltage shall be attenuating current on any frequency between 25 hertz to 100 Hz and approximately of sine-wave form. The r.m.s. value shall be as given in table-1 below :

For A.C. voltage duration of test shall be one minute.

The test with D.C. at a voltage not in excess of the values given in Table-1, Column-3 for the corresponding rated voltage may be substituted for the AC test prescribed.

Table - 1

Rated Highest System Voltage	Test Voltage (A.C.)	Test Voltage (D.C.)
Upto & Including	KV	
3.6	16.8	
7.2	21.6	
4	28	
24	44	
36	60	

E. Megger-Checks :

Before the application of high voltage, check the insulation of each bus, conductors by means of 2.5 KV megger. A value e. 100 mega ohms is expected under normal conditions. However, during mainly season this value may fall down considerably and drying up by hot air may be necessary before the test. Minimum acceptable value is around 20 mega ohms. After the application of high voltage the insulation value is checked gain.

F. Application of Test Voltage :

Corresponding test voltage as indicated in Table-1 shall be applied in turn between each phase conductor and its enclosure which shall be kept at ground potential. Remaining two phase conductors and their enclosure shall be properly as in consistent with its value being indicated by the measuring instrument. The full test voltage shall be then maintained for specified duration. Each section including tap-off must withstand the above test voltage.

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2.2.3.19 Site Test Records on Segregated Phase Busducts :

Test conducted on date..... Site

Power Frequency high voltage test :

Instrument

Phase	Megger Reading		HV applied & duration A.C./D.C.	Leakage current	Remarks
	before HV test	after HV test			
R					
Y					
B					

2.2.4.0 SWITCHGEAR / CONTROL PANELS :

The following points shall be checked up during erection.

- 2.2.4.1 Layout of foundation channels.
- 2.2.4.2 Floor level covered by the panel with respect to main floor level.
- 2.2.4.3 Location and serial no. of panels.
- 2.2.4.4 Positioning of panels.
- 2.2.4.5 Verticality of switchgear panels within the limit specified.
- 2.2.4.6 Frames of Breaker Truck and modules in housing and its manual operation.
- 2.2.4.7 Earthing of panels and breaker truck to station earth.
- 2.2.4.8 Lugs for termination of HT and LT cables.
- 2.2.4.9 Mounting and fixing arrangements of Bus bars.
- 2.2.4.10 Tightening of Busbar jointing bolts as specified.
- 2.2.4.11 Clearance between :
 - i.Phase to Phase
 - ii.Phase to earth

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2.2.4.12 Minimum clearance for :

- i. Breaker, Truck and modules withdrawal
- ii. Distance required for maintenance work

2.2.4.13 Check the operation of :

- i. Remote control
- ii. Various required - closing / tripping / alarm / indications / interlocks

2.2.4.14 Installation position of instruments and relays

Operation of relays and meters by secondary injection.

2.2.4.15 AC/DC supplies for panel

Final relay settings as per customer requirements.

2.2.4.16 Tightness of terminal connections for HT & LT connections.

2.2.4.17 Opening operation of breaker, manually and electrically.

2.2.4.18 Working of ammeters and voltmeters for their entire range and other panel mounted instruments like recorder, indicator etc.

2.2.5.0 TEST FOR GENERATOR RELAY AND CONTROL PANELS :

A. For generator relay panel :

- (i) Functional checks on all the relays in the panel like pickup and drop of voltage and by doing secondary injection.
- (ii) Loop checking of the relays.
- (iii) Checking of interlock and protection as per schemes by Primary injection.
- (iv) Checking of synchronising circuits.
- (v) Calibration of energy meter

B. For generator and transformer control panel :

- (i) Checking of the control circuits.
- (ii) Calibration of the panel meters.
- (iii) Checking of the total annunciator / indication system.
- (vi) Calibration of energy meters.

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2.2.6.0 BATTERY AND BATTERY CHARGER TESTS

Battery

1. Checking for completion of civil/ventilation requirement of battery room.
2. Checking of adequacy of charger output/requirement wrt current required battery charging as per the manual.
3. Check availability of safety devices, water and first aid kit.
4. Check polarity of connections between battery and charger
5. Visual inspection test for level and leakage.
6. Checking of layout as per approved drawing.
7. Checking of IR value from positive to earth and negative to earth.
8. Checking of voltage per cell and total voltage between positive negative and earth to positive/negative and also tap cell voltage (as applicable).
9. Checking of tightness of connectors on each cell.
10. Checking of capacity test and hourly measurement of specific gravity and voltage for each cell.

Battery Charger

1. IR test
2. HV test
3. Checking voltage ratio of boost and float mode transformers
4. Checking for charging mode of batteries, constant current and constant voltage mode.
5. Load test on chargers by running of DC drives and by liquid resistance system.
6. Checking of tightness of earthing connections.
7. Check for all alarm conditions.
8. Checking and calibration of all indicating meters.
9. Check functional operation of charger, auto/manual change over from float to boost and boost to float etc.
10. Checking and setting of all relays

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11. Check AC ripple in boost and float mode after charging.
4. Check polarity of cables connected to battery.

Apart from above following tests also to be carried out.

1. Insulation resistance and earth resistance checks.
2. Primary and secondary injection test.
3. Calibration of all instruments
4. Tests at normal voltage and when required at reduced voltage to prove satisfactory closing and tripping from local and remote points, checking of tripping from relay and protective gear, inter-tripping, interlocks etc. Reduced voltage test at 70% rated voltage to prove tripping of each circuit breaker.
5. Battery capacity test

2.2.7.0 SITE TESTS - FOR THE EQUIPMENT ERECTED BY MECHANICAL CONTRACTOR

The tests to be carried out on the equipment's at which are normally being erected by Mechanical contractor.

a) GENERATOR_:

Generator set with all auxiliaries and controls shall be assembled and tested to verify compliance with the guaranteed technical particulars and for satisfactory performance. Relevant standards shall be followed as guideline for testing. All the tests shall be witnessed by customer or its representative. The commissioning tests shall be carried out at site under normal service conditions.

Following minimum tests shall be carried out on the generators :

1. Insulation resistance test and determination of polarization index value of:
 - **Generator**
 - **Excitor**
 - **Resistance temperature detectors**
2. Dielectric test
3. No load characteristics
4. Short circuit characteristics

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5. Temperature rise at rated voltage, current, power factor and frequency.
6. Overspeed test
7. Vibration tests*
8. Calculation of efficiency
9. Phase sequence/voltage balance/current balance checks.
10. Insulation of bearing pedestal/housing
11. Determination of reactances and time constants.
12. Wave form test and harmonic analysis (Type test results are acceptable).
13. Determination of moment of inertia (Type test results are acceptable).

Note :

1. Vibration tests in the factory to be taken at 100% of synchronous speed and at 40% during overspeed test.
2. Vibration test at site to be taken at 100% of synchronous speed of the complete generator with its driver.
14. Instantaneous short circuit test (Optional).
15. Noise measurement test.
16. Response of voltage and frequency with sudden shedding of 25%, 50%, 75% and 100% of rated load respectively.
17. Response of voltage and frequency with sudden application of 25%, 50%, 75% and 100% rated load respectively.
18. General dimensional alignment checks.
19. Temperature detector test
20. Measurement of DC resistance of winding
21. Pressure test on heat exchangers (cooling system)
22. Inter turn insulation test of stator winding with induced voltage 130% of rated value for 5 minutes (if applicable).
23. Measurement of shaft voltage.
24. String test as per data sheet.

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b) AC MOTORS

1. IR test of stator and rotor windings.
2. Heating of both windings upto the permissible temp.
3. Ensure that checking/testing of associated switchboard, cables, relays/meter interlockings as mentioned in relevant chapters are completed.
4. Check tightness of cable connection.
5. Winding resistance measurement of stator and rotor.
6. Checking continuity of winding.
7. Check tightness of earth connections.
8. Check space heaters and carryout heating of winding (if required)
9. Check direction of rotation in decoupled condition during kick start
10. Measure no load current for all phases
11. Measurement of temperature of body during no load and load conditions.
4. Check for tripping of motor from local/remote switches and from.
13. Checking of vibration (if required).
14. Checking of noise level (if required)
15. During load running, measurement of stator and bearing temperatures (if applicable) for every half and hour interval till saturation comes.
16. Checking tightness of foundation bolts
17. Check operation of speed switch (if there)
18. Check continuity of temp. detectors.
19. Check alignment, paralleling of shafts, level of lubricating oil etc. as per manufacturer's manual.
20. Check contact of slip ring brush and measure brush pressure (150-200 gm/sq. cm)
21. For CACW drive check cooling water and system/piping, availability of pressure, cleaning and pressure testing of pipelines etc.

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22. Check for polarisation index of stator winding, R10/R1 by motorised megger (The value should not be less than 2.0) R60/10 absorption coefficient shall not be less than 1.5.
23. Dielectric test (only for HT motors).
24. Measurement of open circuit rotor winding voltage for slip ring motor.
25. For actuator drives following shall be checked/tested :
 - Visual and dimensional
 - Hydraulic pressure for valves
 - IR and operation of limit switches
 - Winding resistance

c) DC MOTORS

1. IR measurement and heating the winding as per heating curve.
2. Check for earth connection
3. Winding resistance for field and armature.
4. Check running of drive at minimum and maximum specified.
5. Check auto start of drive on failure of AC supply (if applicable)
6. Check operation of overload relay.
7. Measure vibration.
8. Check temperature rise on body of drive after required period of continuous running.
9. Measure load currents and no load currents (if possible).
10. Check direction of rotation.
11. Check continuity of winding.
4. Measurement of RPM.

CONTROLS & INSTRUMENTATION PACKAGE

2.2.8.0 GUIDELINES FOR INSTALLATION OF C & I EQUIPMENTS

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- 2.2.8.1 Instruments location shall be decided to the convenience of operation and maintenance. The location shall have least mechanical vibration and placed where corrosive, toxic and explosive gases and dust particles will not deposit and the place is not subject to high-temperature atmosphere or radiation. However, actual location shall be decided in consultation with customer/consultant.
- 2.2.8.2 Maintenance platforms & approach facilities shall be provided for all sensing & primary devices wherever possible.
- 2.2.8.3 Instruments shall be located in weatherproof enclosures and wherever required suitable canopy shall be provided.
- 2.2.8.4 High & Low pressure impulse lines shall not be grouped and run together. Also impulse lines for explosive & inert gases shall not run together.
- 2.2.8.5 Impulse lines of high pressure steam, harmful gases, etc. shall not be brought into the control room, as far as possible.
- 2.2.8.6 Intrinsically safe circuits shall be used for explosion hazardous areas.
- 2.2.8.7 Separate cable routing shall be followed for high and low voltage lines.
- 2.2.8.8 All electrical equipments shall meet the requirements of Indian Electricity Rules.
- 2.2.8.9 Wherever severe vibrations are expected, shock absorbers shall be provided.
- 2.2.8.10 Before and after regulating/control valves, straight pipe lengths of 10 mm dia. on either side must be ensured.
- 2.2.8.11 Installation of instruments with radioactive isotopes, mercury and other toxic substances shall be as per statutory regulations provided by authorities.
- 2.2.8.4 Compensating cables should be connected directly to instruments, i.e. no junction boxes shall be used if CJCBs are not provided..

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- 2.2.8.13 Orifice plates or flow nozzles must be provided with at least 10D upstream and 5D downstream straight length of pipe from bends tees, branch pipes & control valves.
- 2.2.8.14 Control valves shall be installed after orifice plates.
- 2.2.8.15 Pressure gauges shall be provided with snubbers, syphons (for more than 100°C), 3 way valve manifolds wherever applicable.
- 2.2.8.16 For pneumatic instruments, air shall be dry & free from oil. Air must be supplied from oil-free compressors specially erected for this purpose. After drying, air must be stored in receiver. Pressure gauges must be provided on each supply line and after the pressure reducer.
- 2.2.8.17 Correct level (height) between detecting element and tapping point and transmitter shall be maintained.
- 2.2.8.18 The equipment shall maintain its normal posture (level, perpendicular, front and back).
- 2.2.8.19 Connection between detecting element/tapping point and transmitter shall be maintained at short distances wherever practicable to avoid any time lag.
- 2.2.8.20 Orifice plates and control valves shall be mounted on process piping, only after completion of cleaning of the process piping in order that these instruments may not suffer damage from metal waste, etc.
- 2.2.8.21 For details of installing each measuring instruments, instruction manual issued by the respective manufacturer of instruments may be referred to, wherever necessary.
- 2.2.8.22 The drain pipes shall be terminated in a common closed header and finally the common header shall be connected to plant open drain.
- 2.2.8.23 Impulse pipe material shall be identified for each individual pipe prior to its use at site. For this purpose coloring is to be done immediately after receipt.

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2.2.9.0 GUIDE LINE FOR ERECTION OF IMPULSE LINES

- 2.2.9.1 All impulse lines burrs and airlines shall be thoroughly cleaned of any foreign matter by cleaning with compressed air and the same shall be done before installation.
- 2.2.9.2 The routing of pipelines shall include sufficient flexibility near tapplings to allow for thermal expansion of the process equipment.
- 2.2.9.3 The pipes shall be cold bent using hydraulic bending machines only.
- 2.2.9.4 The horizontal impulse lines shall be laid with proper slopes towards the tapping point.
- 2.2.9.5 Supports for piping and tubing shall be adequate and in no case exceed limits shown below:
- | | |
|----------------------------|------------|
| a) 1/4" OD/ 3/8" OD Copper | Continuous |
| b) 1/2" NB Pipe/Tube | 5' |
| c) 3/4" NB Pipe/Tube | 5' |
| d) 1" NB Pipe/Tube | 8' |
- 2.2.9.6 All impulse line welding shall be done through welding generator/rectifier and only structural welding could be done through welding transformer.
- 2.2.9.7 Impulse pipe of Alloy Steel/SS/CS shall be TIG welded wherever required. Welding of impulse pipe shall be carried out in accordance with BHEL welding procedure. The welding electrodes shall be approved by BHEL welding Engineers. Impulse pipes welders shall undergo welding Test and approved by BHEL welding engineer at site.
- 2.2.9.8 Minimum number of fittings shall be used on all lines wherever possible, to keep threaded joints to a minimum wherever thread connections are to be made.
- 2.2.9.9 The impulse pipe laying is recommended to be limited to a maximum of 10 metres (each limb) generally, unless otherwise specified, to have optimum response from the transmitter. However, this will depend upon plant layout.

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- 2.2.9.10 Where the tapping point is subjected to mechanical shift due to heating/cooling of main equipment, care should be taken to route the impulse pipe in such a way as to absorb the shift of tapping point without straining the impulse piping. To accommodate this, sufficient loop for the impulse pipes can be provided near to the tapping point.
- 2.2.9.11 Alternatively hose assembly - S.S. flexible may be used for connection between tapping point and impulse pipe.
- 2.2.9.4 The expansion bends are to be avoided as far as possible, as these act as air/sedimentation traps hampering the system performance.
- 2.2.9.13 Impulse piping shall be arranged as short as possible with a minimum of bends.
- 2.2.9.14 Horizontal piping shall be avoided and 1/10 slope shall be maintained.
- 2.2.9.15 Pipes shall not be laid parallel to high temperature process piping.
- 2.2.9.16 Pipe joints shall be carried out using sockets and flanges. Union fittings may be used when pressure is low. In the case of D.P. instruments both piping on low side and high side shall be maintained at same length and in the same route.
- 2.2.9.17 **Impulse Piping for Air & Flue Gas System**
- For furnace pressure and furnace flue gas, suitable piping for air and furnace flue gas pressure, the impulse pipe shall be arranged to rise vertically from the tapping point to a distance at least of 300 mm before a change of direction is made.
- 2.2.9.18 Arrangements should be made for air purge in the impulse piping system at the end of the instrument airline or roding facilities may also be provided with suitable tees and cross.
- 2.2.9.19 In order to take care of the boiler expansion, suitable flexible connecting pipes can be arranged either at the tapping point end or at the instrument end.

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2.2.9.20 **Impulse Piping for Vacuum Measurement**

The measuring instruments used on vacuum measurement should always be installed above the level of the tapping point in order to minimise measuring errors as much as possible. A suitable condensing chamber can be arranged which will eliminate the condensate or any blocking in the impulse pipe.

2.2.9.21 **Impulse Piping for Steam and Water System**

As a rule, instrument installation position for steam and water shall be downward from root valves.

2.2.9.22 Impulse pipes shall have a minimum slope of 1:10 and shall be supported at every 2 metres length.

2.2.9.23 At the transmitter end, the connection can be either through 2 way valve manifold or nipple with coupling.

2.2.9.24 In case 2 way manifold used and connected with nipple and coupling, it is necessary to provide tee with plug for purging or venting. The impulse pipe connection to the transmitter from the main pipe may be either upper side or lower side of the transmitter. In any case sufficient slope shall be maintained.

2.2.9.25 Some supplier recommends capillary type tube for transmitter connection from the impulse pipe to instrument by using S.S. tube and compression fittings.

2.2.9.26 It is always preferable to mount the instrument below the tapping points because the condensate shall protect the instruments against high temperature. In any case, the temperature entering the instrument should not exceed 150 F. In case the instrument is installed above tapping, before opening the process root valves, the impulse pipe shall be filled with water.

2.2.9.27 In the case of high temperature steam applications, sufficient length or siphon shall be provided to ensure certain length of condensate is formed thereby protecting breaking the measuring instruments from high temperature. Snubbers can also be provided if there is likely to be any pulsating of the medium measured.

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2.2.9.28 **Bending**

It is recommended for cold bend for the impulse pipes with the help of a hydraulic bending machine to achieve a particular shape.

2.2.9.29 Use of 45° elbow and 90° bends (ready-made) is restricted to bare minimum to minimise the number of joints in a system. Hot bending is not to be used as this leads to flattening of pipes at the bends and also results in thinning of walls, apart from introducing changes in metallurgical properties of the pipe material.

2.2.9.30 Hot bending may be permitted for carbon steel pipe for low pressure service as instructed by supervisor only when it cannot be avoided. In the case of 90° bending radius shall be more than 3 times the outside diameter of pipe and in the case of 'u' bending, radius of bending shall be 5 times the outside diameter of pipe. When the radius of bending becomes small, elbow fitting shall; be used.

2.2.9.31 Large bending shall be so made as to form smooth curve.

2.2.9.32 **Cutting**

- Pipe cutter or wheel grinder shall be used for pipe cutting.

- Gas cutting shall be avoided.

- Burr inside the cut end shall be removed.

- The cutting surface shall be as perpendicular to the axis as possible.

2.2.9.33 **Impulse Pipe Welding**

Generally, welding of impulse pipe and fitting shall be carried out by arc welding and socket welding is adopted. Welding shall be performed by a qualified welders. Only D.C. arc welding is recommended for impulse pipe. Motor generator is preferred to rectifier transformer, since it may damage the welding joints due to surge.

In order to prevent the cracking of the weld it is recommended to provide a small gap between the bottom of the socket and pipe end.

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2.2.9.34 Testing

On completion of pipeline, installation, the pipelines shall be hydraulic tested. Contractor shall arrange for hydraulic pump and standard gauges and conduct the test satisfactorily.

The impulse lines shall be isolated from the instruments and tested at 2 times the maximum working pressures. The fall in pressure shall not be more than 1 Kg/Cm² or 1% of the working pressure whichever is less, in 30 minutes and there shall be no leaks, at any of joints/welds, when isolated from source of pressure.

2.2.10.0 GUIDELINES FOR INSTALLATION OF PNEUMATIC LINE

2.2.10.1 Copper tubing shall be connected with Olive type of compression fittings,

2.2.10.2 When two or more lines run together, the joint in the adjacent alternate line shall be an offset.

2.2.10.3 In case of copper tubing, the single run copper tube may be supported with an angle. However, suitable trays shall be used for more than one tubing.

2.2.10.4 Multi-core copper tubing shall not be bent less than 10 degrees and D is the OD of the multi-core copper.

2.2.10.5 All air distribution, main and branch lines shall be galvanised internally as well as externally and the galvanised pipe, never, shall be braced or welded.

2.2.10.6 The joints shall be screwed with Teflon tapping wherever the pipes are to be removed frequently for cleaning and other purposes and suitable union fittings shall be used.

2.2.10.7 Care shall be taken while taking a branch pipe to see that the line is not taken from the lower part of the main line or main header in order to avoid entry of any drain or dust into the system.

2.2.10.8 Instrument airline should not be routed where severe vibration, high temperature exists and adequate space should be available for maintenance.

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2.2.10.9 Care shall be taken when removing the PVC sheeting, while connecting the copper tube. The exposed portion after jointing shall not be excessive and also while removing PVC, the tube should not get damaged. Pipe cutters should not be used for cutting the copper tube, instead the specific copper tube cutter shall be used. Similarly, for bending copper tubes, specific copper tube bender should be used and the radius of the bending shall be more than 2.5 times of the OD of the copper tube.

2.2.10.10 While using the pipe cutter, care shall be taken to remove burr from the cutting side.

2.2.10.11 In locations where the copper tube is likely to be damaged from outside, the copper tube can be routed near a different pipe. While laying copper tube either inside angle or trays, the tube shall be supported at least at every one meter distance.

2.2.10.4 While fixing the copper tube fittings only Teflon tapes should be used. However, no tape shall be used while tightening the ferrules.

2.2.10.13 **Instrument Air line Testing**

–All instrument air lines shall be isolated from the instruments and pressurised pneumatically to maximum working pressure. It shall then be isolated from the source of pressure and fall shall be less than 1 psi in 20 minutes.

–All pneumatic signal lines shall be disconnected and blown through with instrument air. The line shall be blanked off and pressurised pneumatically 20 psi, and checked with soap solution for leak.

2.2.11.0 **GENERAL GUIDELINES ON INSTALLATION OF FLEXIBLE HOSES**

Flexible hoses can be classified into two broad categories, viz., Rubber hoses and Metallic hoses. The selection of the hoses is made depending upon the service conditions (pressure, temperature and other environmental conditions).

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- 2.2.11.1 Under pressure, a hose may change in length. Always provide some slack in the hose to allow for this shrinkage or expansion. (However, excessive slack in hose lines is one of the most common causes of poor appearance).
- 2.2.11.2 At bends, provide enough hose for a wide radius curve. Too tight a bend pinches the hose and restricts the flow. The line could even kink and close entirely. In many cases, use of the right fittings or adapters can eliminate bends or kinks.
- 2.2.11.3 In applications where there is considerable vibration or flexing, allow additional hose length. The metal hose fittings, of course, are not flexible and proper installation protects metal parts from undue stress, and avoids kinks in the hose.
- 2.2.11.4 Hose assemblies in service should be inspected frequently for leakage, kinking, corrosion, abrasion or any other signs of wear or damage. Hose assemblies that are worn or damaged should be removed from service and replaced immediately.
- 2.2.11.5 The service life expectation of a flexible hose mainly depend on the correct installation layout. In most cases, when flexible hoses fail prematurely, the reason of failure may be found in an incorrect layout.
- 2.2.11.6 As a rule, the hose is not to be bent over its limit of elasticity. The choice of the right hose length is of crucial importance. The hose should not be subject to torsion. Torsion can be usually eliminated by changing the layout.

2.2.12.0 GENERAL NOTES ON INSTALLATION OF LOCAL INSTRUMENT RACKS AND JB FRAMES

- 2.2.12.1 In **cases** where the local instrument stands are to be installed on a concrete foundation, it shall be fixed by anchor bolts.
- 2.2.12.2 In cases where the local instrument stands are to be installed on the base plate, the stand can be placed on an angle and the same can be welded. However, in cases where there is a probability for removal of stand is likely to arise, it shall be fixed by bolts.

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2.2.12.3 Installation of local junction boxes shall be installed in such a way that they are fixed on a column by welding or by fixing bolts.

2.2.12.4 Local Instrumentation rack, which shall be installed utilising the Beam and Structure, shall be fixed by welding. Care shall be taken while deciding the location in order to ensure that no hindrance is caused to the maintenance personnel in their moving space within the work area. Further, as a standard practice, it should be ensured that no instrument stands/racks/JBs shall be supported by/welded on to any of the working equipments, or even hand grided or floor grided, as per safety norms.

2.2.12.5 Proper care should be taken to ensure that welding of the stand on any structure or Beam is fully welded.

2.2.13.0 GENERAL GUIDELINE ON FLOW INSTRUMENTS INSTALLATION

2.2.13.1 Extreme care shall be taken when welding and assembling the flow element on the pipe. Any misalignment or rough particle or edge inside the welded area may cause inaccuracy and this will increase as the flow increases.

2.2.13.2 Flow elements should always be located in upstream from any valve. Downstream side of valve shall no longer be a homogenous mixture and this may cause erratic behaviour of reading periodically.

2.2.13.3 Care shall be taken while welding the impulse pipe. Improper arrangement of piping of DP instruments can create error in the reading and even it gives an indication of negative flow of steam even though the flow is to be positive. Inadequate exchange of steam and condensate in the piping may cause negative flow. The presence of burr or dirt in the pipe can impede the flow of condensate back to the pipe, and when this happens, the pipe becomes full of water and has the effect of creating negative head.

2.2.13.4 Always ¾" to 1" pipe is recommended for free flow condensate. Gate valve shall be used for the tapping and pipe should be insulated up to condensing pot.

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- 2.2.13.5 The Measuring instrument shall be located close to the flow-sensing element. The speed of response is reduced if there is a long run,
- 2.2.13.6 The orifice plates shall be installed such that the extreme face is perpendicular to the axis of the pipe within the +2 deg or -2deg. and it should be ensured that when the extreme face is facing the direction of flow, invariably the sign of positive (+) is marked on the upstream.
- 2.2.13.7 Location of Flow element should have clear straight run of 10D in upstream and 5D in downstream.
- 2.2.13.8 For non-viscous liquid flow measurements, the best location for the instruments shall be below the pipeline, If the instrument is above the line, more maintenance will be involved. Suitable vapour traps shall be provided.
- 2.2.13.9 In the case of air and gas flow measurement system, as part of basic requirement, it should be transmitted to the instruments without any change in the differential head due to leakage.
- 2.2.13.10 If the flow of any dry gases are to be measured, the location of instrument can be kept above or below the tapping points.
- 2.2.13.11 For air flow measurements, it is always preferable to install the instruments above the pipeline. Incase, if the instrument must be installed below the duct/pipeline, suitable Dust Collection Chamber can be installed.
- 2.2.13.4 The condenser pot should be located nearer to the tapping point and both condenser chamber should be at the level of upper tapping,
- 2.2.13.13 The unequal level will cause significant error due to false heads. If the flow nozzle is installed in vertical pipe, the lower tapping pipe which is bent and taken up to upper tapping in order to align with the upper condensate pot, must be insulated, otherwise, error is created when the bent pipe fills with condensate. The error may add or subtract depending upon the direction of flow.

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- 2.2.13.14 For flow measurements, the instruments should always be located below the condenser pot, otherwise, the condensate will be lost from the system and the instrument will reach 'O' during the shutdown and the total system must be vented after the start up of the boiler in order to remove Air and Vapour which might have got entrapped.
- 2.2.13.15 In an installation where the instruments must be located above the tapping points and the condensing chamber should be equally located above the instruments the pipeline up to the condensing pot should be insulated.
- 2.2.13.16 In the case of viscous fluids, flow measurements which are likely to freeze or concealed in the pressure pipe or like such corrosive type fluids, suitable sealing chamber shall be used, the sealing liquid should not mix or react with the medium to be measured.
- 2.2.13.17 The commonly used sealing liquid includes water, light oil, glycerol, ethylene glycol and mixtures of the last two with water.
- 2.2.13.18 The sealing chambers, in each pressure pipe, should be installed at the same level and as close as possible to the pressure tappings.
- 2.2.13.19 The general arrangement for pressure tappings from the Sealing Chamber to the instrument is shown in the sketch.
- 2.2.13.20 The flow elements should be inspected before installation to find out the presence of any corrosion/rusting or any blockage on the pressure tapping holes or any deposits on the face of the orifice plate.
- 2.2.14.0 GENERAL GUIDELINE ON INSTALLATION OF VALVES**
- 2.2.14.1 Primary isolating valves (root valves) must be located at the tapping which can be of globe valves.
- 2.2.14.2 These valves shall be installed where access is possible.

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- 2.2.14.3 Secondary isolating valves shall be located at the end of inter-connecting pipe. It should be as nearer as possible to the measuring instruments and should be of needle type.
- 2.2.14.4 For pressure more than exceeding 40 kg, 2 isolating valves shall be provided.
- 2.2.14.5 In the case of heavy duty isolating valves, suitable support shall be provided to avoid any loading on the stubs.
- 2.2.14.6 In viscous fluids, suitable steam tracing shall be provided.
- 2.2.14.7 These valves are always located as nearer to the measuring device as possible.

2.2.14.8 Blowdown Valves or Drain Valves

- a) These valves are fixed at the lowest end of impulse pipe.
- b) In the case of high-pressure line always 2 valves shall be fitted in series. Normally, these valves will be of globe type.
- c) For low-pressure application, single valve is used.
- d) In case of air and flue gas measurements, either a plug or a suitable gate valve of gunmetal 'on/off' valve shall be provided.
- e) The drain valve shall be connected to the common drain header which finally is terminated at plate operation drain system.

2.2.15.0 GUIDELINES FOR CABLE LAYING

- 2.2.15.1 In the plant building, substations, switchgear rooms, control rooms etc. Power and control cables shall generally be laid on cable trays installed in concrete trenches, tunnels, cable basements, cable vaults, cable shafts or along building and structures as the case may be.

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- 2.2.15.2 In case of multicore cables of diameter upto 20 mm where not more than 3 cables are taken in one run, these can be taken directly along structures, walkways, platforms, galleries, walls, ceiling etc. by proper clamping at regular intervals of more than 300 mm.
- 2.2.15.3 Power & control cables installed along buildings and structures, ceilings, walls, etc. which are required to be protected against mechanical damage shall be taken in G.I. conduits.
- 2.2.15.4 GI conduits shall also be used for flameproof installations, wherever required, with sealing at both ends.
- 2.2.15.5 In corrosive atmosphere, where 1100 V grade cables are required to be taken in pipes, rigid heavy-duty PVC pipes shall be provided.
- 2.2.15.6 Entry of cables through trenches/tunnels into buildings shall be by means of one of the methods indicated in drawing as applicable for different buildings.
- 2.2.15.7 Cables laid exposed in racks/trays and routed through trenches/tunnels/basements etc. to individual drive/control devices etc. shall be taken in embedded surface exposed rigid GI conduits and or flexible conduits unless directly terminated to the equipment in the panels located, above trenches, tunnels or basement.
- 2.2.15.8 All cables routed along walls or in equipment rooms shall be protected by means of laying them through GI pipes or by providing sheet metal covers up to a height of 2000mm from the working floor levels and platforms, for protection against mechanical damage. All vertical risers shall be of enclosed type.
- 2.2.15.9 Tray covers shall not be provided for the cable trays within trenches, tunnels and basements. Non-perforated type sheet steel covers shall be provided for the trays in the areas susceptible to accumulation of coal dust/atmospheric abuses etc.
- 2.2.15.10 Cable trays shall be supported on ISA 50x50x6mm MS/GI brackets. Brackets shall be welded to steel plate inserts in the trenches/tunnels or supporting channel angle/inserts in other areas.

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- 2.2.15.11 Wherever direct heat radiation exists, heat isolating barriers (subject to customers approval), for cabling system shall be adopted.
- 2.2.15.4 For 415V power wiring in ancillary buildings, offices and laboratories, cables shall be taken through embedded/exposed GI conduits or rigid PVC pipes as applicable.
- 2.2.15.13 If required, a few number of cables in exceptional areas may be directly buried into the earth.
- 2.2.15.14 Wherever cables are to be laid below roads and railway tracks, the same shall be taken through ducts buried at a suitable depth as decided by Engineers.
- 2.2.15.15 At certain places where hazardous fumes/gases may cause fire to the cables, cable trenches after installation of cables may be sand-filled.
- 2.2.15.16 In corrosive atmosphere, PVC conduits shall be used for cables.
- 2.2.15.17 Single core cables, when pulled individually shall be taken through PVC pipes only.
- 2.2.15.18 Laying and installation of power, control and special cables shall generally conform to IS : 455
- 2.2.15.19 The cables shall be laid-out in proper direction from the cable drums (opposite to the normal direction of rotation for transportation).
- 2.2.15.20 In case of higher size cables, the laid out cables shall run over rollers placed at close intervals and finally transferred carefully on the racks/trays. Care shall be taken so that kinks and twists or any mechanical damage does not occur to cables. Only approved cable pulling grips or other devices shall be used. Under no circumstances cables shall be dragged on ground or along structure while paying out from cable drums, carrying to site and straightening for laying purpose.

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- 2.2.15.21 Suitable extra length of cables shall be provided for all feeders for any future contingency, in consultation with Engineer.
- 2.2.15.22 Cable runs shall be uniformly spaced, properly supported and protected in an approved manner. All bends in runs shall be well defined and made with due consideration to avoid sharp bending and kinking of cable. The bending radius of various types of cables shall not be less than those specified by cable manufacturers and that specified in IS 455.
- 2.2.15.23 All cables shall be provided with identification tags indicating the cable numbers in accordance with the cable circuit schedule. Tags shall be fixed at both ends of cables (both inside & outside of panel) both sides of floor/wall crossings, every 25m spacing for straight runs or as specified by Engineer for easy identification of cable.
- 2.2.15.24 When a cable passes through a wall, cable number tags shall be fixed on both sides of the wall.
- 2.2.15.25 Single core cables for AC Circuits shall form a complete circuit in trefoil formation supported by means of trefoil clamps of non-magnetic material.
- 2.2.15.26 Multi-core cables above 1100 V grade shall be generally laid in ladder type trays in one layer with spacings not less than one cable diameter of bigger diameter cable.
- 2.2.15.27 All 1100 V grade multicore power cables and single core DC cables shall be placed in single layer, touching each other and clamped by means of single or multiple galvanised MS saddles/aluminium strips/nylon cable ties. Cables above 35mm diameter shall be clamped individually.
- 2.2.15.28 Control cables shall be laid touching each other and wherever required may be taken in two layers. All control cables shall be clamped with a common clamp/tie.
- 2.2.15.29 Segregation of the cables on the basis of their types and their functions shall be as under for horizontal formation:

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a) HT cables shall be laid in the top tier(s)

b) LT power cables to be laid in the tray(s) below the HT cable trays.

c) LT control cables to be laid in the Tray(s) next below to the LT power cable (trays)

d) Special control cables including screened control cables to be laid in the bottom most tray(s).

2.2.15.30 For vertical formations, the trays closest to the wall shall be considered as bottom most tray and the order indicated in clause just above shall be followed. However, where there is no clear distinction of bottom/top trays, the order convenient for linking the horizontal and vertical formations shall be followed.

2.2.15.31 When it may not be possible to accommodate the cables as per the criteria indicated in the two clauses indicated above, the following rules shall override the criteria. However, prior approval of the Engineer will be required.

a) Control cables are mixed up with the special control cables with clear minimum gap of 100mm between them.

b) LT power cables are mixed up with control cable with clear minimum gap of 150mm between them.

c) LT power cables are mixed up with HT power cables with clear minimum gap of 200mm between them.

d) LT power cables are mixed up with special control cables with clear minimum gap of 200mm between them.

2.2.15.32 In case of duplicate feeders to essential loads, the respective cables shall be laid through separate raceways. Alternatively, such cables shall be laid on the opposite sides of a trench/tunnel/basement.

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- 2.2.15.33 For laying cables along building steel structures and technological structures, the cables shall be taken by clamping with MS saddles screwed to the MS flats welded to the structure. MS saddles and flats shall be galvanised.
- 2.2.15.34 For laying cables along concrete walls, ceilings etc. The cables shall be taken by clamping with MS saddles screwed to the MS flats welded on the inserts. Where inserts are not available the saddles shall be directly fixed to the walls using raw plus and MS flat spacers of minimum 6mm thickness.
- 2.2.15.35 To facilitate pulling of cables in GI conduits, powdered soft stone, plastic soap or other dry inert lubricant may be used but grease or other material harmful to the cable sheaths shall not be used.
- 2.2.15.36 No single core cable shall pass through a GI conduit or duct except DC single core cables. AC single core cables shall pass through GT conduits/pipes in trefoil formation only.
- 2.2.15.37 In case of a 3 phase, 4 wire system, more than one single phase circuit, unless originating from the same phase shall not be taken in the same GI conduit.
- 2.2.15.38 Entry of cables from underground trenches to the buildings or tunnels shall be by some approved method. Necessary precautions shall be taken to make the entry point fully water tight by properly sealing the pipe sleeves wherever they enter directly into the building at trench level. The sealing shall be by cold setting compound. Any alternative sealing arrangement may be suggested with the offer for consideration by BHEL.
- 2.2.15.39 Wherever specific cable routes are not shown in cable schedules cables shall be laid as directed by Engineer.
- 2.2.15.40 Support Spacings & Clampings**
- Support spacing and clamping suitably provided and as required

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2.2.15.41 Laying of cables directly buried in ground

Laying and installation of directly buried cables in ground shall conform to the requirements of IS 455.

2.2.16.0 DESIGN REQUIREMENT FOR EQUIPMENT AND MATERIAL - FOR SUPPLY ITEMS.

2.2.16.1 CABLE GLANDS

Cable glands shall be tinned or nickel plated brass, single/double compression type, weather/explosion-proof as the case may be complete with necessary armour clamp and tapered washer etc. Cable glands shall match with the sizes of different cables as indicated in the Schedule of Rates

2.2.16.2 STRIP CABLE CLAMPS

a) Strip Clamps shall be of aluminium alloy or cast steel or M.S. and shall be used to fasten the group of multicore cables on the tray.

b) Clamps shall be of simple construction, made of 4 mm thick, 25 mm wide strip to cover the entire width upto 300 wide tray and part of the tray for more than 300 wide trays. Strip shall have two right angle bends for fixing on the rung with two bolts.

c) Clamps shall be of different lengths for different sizes of tray width. The maximum size of clamp width shall be 300 mm and for cable trays of greater width, two clamps shall be used.

2.2.16.3 SELF LOCKING CLAMPS

a) Clamps shall be of nylon material/fibre glass.

b) Clamps shall have self locking feature when the cord is looped.

c) Clamps shall be provided with manual lock release.

d) Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.

e) Type test certificates to ascertain the strength of clamps shall be submitted for purchaser's approval.

f) Nylon self locking clamps shall be of BHEL approved make only.

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2.2.16.4 FERRULES

- a) Ferrules shall be required for individual core of cable hence they shall be suitable for the insulated conductor diameter.
- b) Ferrules shall be of plastic material.
- c) Numbering on the ferrules shall be engraved type with contrast colour to the base. Engrave colouring shall be of durable quality to match the entire life of the plant. Engraving shall be legible from a distance of 600 mm.
- d) Ferrules shall be interlocking type in such a way that the interlocked ferrules take the shape of tube with complete ferrule number appearing in a straight line.

2.2.16.5 TAGS

- a) Cables shall be provided with cable number tags for identification.
- b) Cable tags shall be of durable fibre, aluminium or stainless steel sheets.
- c) Cable number shall be engraved type in case of aluminium or stainless steel tags, and printed type in case of fibre sheet.
- d) Tags shall be durable quality of size 60 mm x 4 mm with holes at both ends.
- e) Samples of tags shall be approved by BHEL Engineer before delivery.
- f) Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

2.2.16.6 PVC Tapes, Special Tapes and supporting arrangements.

2.2.16.7 CABLE LUGS:

Cable lugs shall be tinned copper lugs suitable for termination of different sizes of HT/LT/Control cables as indicated in the Schedule of Rates. Lugs for power cables shall be compression type whereas lugs for control cables shall be insulated terminal crimping type. Lugs shall be supplied with sleeves.

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2.2.16.8 STEEL FABRICATION:

Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edges. The painting of the fabricated steel shall be as per the requirement of this specification.

Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 2% of the total quantity of steel fabricated.

2.2.16.9 SURFACE TREATMENT

Two coats of abrasion resistant synthetic enamel of desired colour shall be applied on the pretreated surface with sufficient time interval for drying up. Surface finish after the painting shall be smooth, uniform and free from spots.

2.2.16.10 GALVANISED ITEMS shall be given a surface treatment only at the welded joints and at the places where the galvanisation has been damaged. Welded joints shall be applied with two coats of cold zinc paint whereas damaged galvanising shall be applied with single coat of zinc paint.

2.2.16.11 In addition to the above, the contractor shall ensure after completion of cable erection work that the final finish of all surfaces of trays and support materials is in good condition and wherever needed a touch up of enamel/cold zinc paint, as applicable shall be given.

2.2.16.4 The final finish of all erected materials shall be uniform, clean, smooth and free from spots.

2.2.17.0 GUIDELINES FOR ERECTION OF CABLE TRAYS, GI PIPES , SUPPORTS AND ACCESSORIES

2.2.17.1 Constructional details and supporting arrangement for the cable trays shall be as shown in the drawings which will be handed over to the successful bidder. All cable trays, vertical raceways and supporting steel work shall be installed along the routes as indicated in the drawings and as per the instructions of the Engineer-in-charge. The contractor has to fabricate and install

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- complete tray supporting structures as per the drawing/site requirement.
- 2.2.17.2 Wherever specified or directed by Engineer, the contractor shall install galvanised MS sheets covers over cable trays. The width of the covers shall be same as that of cable trays. Bolting shall be done to fasten covers to the cable trays, elbows, reducers, tees, crosses etc.
- 2.2.17.3 The contractor shall install all angles, channels, beams, hangers, brackets, clamps etc. as may be necessary to suit the actual site conditions to support the cable trays.
- 2.2.17.4 Straight pieces of standard MS angles/channels shall be used for fabrication of supports/racks. All welded joints shall be smooth enough to provide a good appearance and shall not cause injury to working personnel.
- 2.2.17.5 Cable trays within cable trenches, tunnels and basements shall be of ladder type. Bottom most tray within plant buildings for overhead runs of trays shall be of perforated type. Cable trays in the areas exposed to coal dust shall be installed in vertical formation. Wherever due to layout constraints, it is not possible to install the trays in vertical formation with Engineer's prior permission installing the trays in horizontal formation may be considered.
- 2.2.17.6 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way or maintenance of adjacent equipment.
- 2.2.17.7 For installation of cables in GI conduits the conduits shall be installed first without cables but having suitable pull wires laid in conduits.
- 2.2.17.8 For equipment and devices having GI conduit entry arrangement other than standard GI conduit adopter, adopters shall be provided as required to enable the GI conduit to be properly terminated, between conduit end and motor T.B.
- 2.2.17.9 GI conduits shall run without moisture or water traps and shall be made drawing arrangement towards the end.
- 2.2.17.10 The entire GI conduit system shall be firmly fastened in position. All boxes and fittings shall generally be secured independently from the GI pipes entering them.

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- 22.17.11 Bends of GI pipes/conduits shall be made without causing damage to the pipes/conduits.
- 2.2.17.4 Occupancy of conduits shall not be greater than 40%.
- 2.2.17.13 The adopter for coupling rigid GI pipe/conduits and flexible conduit shall be of aluminium or galvanised steel.
- 2.2.17.14 Transportation and storage of cable drums
Transportation and storage of cable drums shall generally conform to the requirements of IS : 455
- 2.2.17.15 All the cables shall be supplied to the contractor free of cost from BHEL/Customer's store/storage area. Transportation of cables from storage area to the work site shall be the responsibility of the contractor.
- 2.2.17.16 The cable drums shall be transported on wheels to the place of work.

2.2.18.0 GUIDELINES FOR CABLE TERMINATION AND JOINTING

- 2.2.18.1 Contractor shall carry out cable terminations at various electrical and electronic equipment terminals.
- 2.2.18.2 When the equipment are provided with undrilled gland plates for cable/conduit entry into the equipment, drilling and cutting on the gland plate and any minor modification work required to complete the job shall be carried out at site and drawings shall be prepared and take engineer's approval before drilling holes. Cutting shall not be allowed.
- 2.2.18.3 Termination of cables shall be done as per termination drawings & interconnection diagrams furnished to the contractor. Looping of cores/wires at terminals as shown in interconnection diagrams is to be done by the column at no extra cost as part of the termination.
- 2.2.18.4 All cable entries in the equipment shall be sealed after glanding the cables..
- 2.2.18.5 Adequate length of cables shall be pulled inside the switch boards, control panels, terminal boxes etc. as per near termination of each core/conductor.

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- 2.2.18.6 Power cable terminations shall be carried out in such a manner as to avoid strain on the terminals by providing suitable clamps near the terminals.
- 2.2.18.7 Control cable cores entering switchboard or control panels shall be neatly bunched and strapped with PVC perforated tapes/nylon ties and suitably supported to keep them in position at the terminal block. All spare cores shall be connected to spare terminals wherever possible. If spare terminals are not available, spare cores shall be neatly dressed and suitably taped at both ends.
- 2.2.18.8 Screened control cables of 0.5 sq. mm cross-sectional area shall be terminated by means of Maxi-termi termination system (if applicable).
- 2.2.18.9 Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per the control schemes and other related documents supplied.
- 2.2.18.10 End sealing/termination of cables shall be done by means specified on the specification for terminations. The system shall be suitable for types of cable specified and complete with stress relief system.
- 2.2.18.11 Termination and jointing of aluminium/copper conductor power cables shall be done by means of compression method using compression type aluminium/tinned copper lugs.
- 2.2.18.4 Copper conductor control cables shall be terminated directly into screwed type terminals provided in the equipment. Wherever control cables are to be terminated by means of terminal lugs, the same shall be of tinned copper compression type.
- 2.2.18.13 Cable joints shall normally be made at an intermediate point in the straight run of the cable only when the length of the run is more than the standard drum length supplied by the cable manufacturer. In such cases, when jointing is unavoidable, the same shall be made by means of specified cable-jointing kit, subject to BHEL's approval of Engineer shall be taken for deciding location of joint.
- 2.2.18.14 Junction boxes shall be used, wherever required, for jointing of control cables.
- 2.2.18.15 Termination and jointing shall generally conform to the requirements of IS : 455 and shall strictly conform to the recommendations of termination and jointing kit supplier.

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2.2.19.0 INSPECTION OF CABLES, TRAYS & TRAY SUPPORT

MATERIALS

2.2.19.1 The following shall be the stages of inspection by BHEL/Customer **(IF SUPPLY IS COVERED IN CONTRACTOR'S SCOPE) :**

a) Inspection of all erection materials hardware items supplied by the contractor.

b) Inspection of storage and material handling.

c) Inspection of fabrication processes such as shearing, punching, bending, welding, galvanising, painting, etc.

d) Inspection at intermediate stages of erection.

e) Final inspection after erection.

2.2.19.2 The actual inspection shall be carried out as per the quality plan of BHEL/Customer.

2.2.19.3 Testing of Cables :

The contractor shall submit to the Engineer a checklist for testing and commissioning and the activities shall be carried out in accordance with the checklist.

2.2.19.4 Testing and electrical measurement of cable installations shall conform to IS : 455

2.2.19.5 Prior to installation, cables shall be tested for :

a) Continuity of conductors

b) Insulation resistance between conductors & earth

c) Insulation resistance between conductors.

2.2.19.6 After installation cables shall be tested for :

a) Insulation resistance between conductors & iron

b) Insulation resistance between conductors & earth

c) Conductor resistance

d) Capacitance between conductors (for cables above 7C.1.7C.1.kV grade)

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- e) Capacitance between conductors & earth (for cables above 7C.1.3KV grade)
- f) DC high voltage test (for HT cables/LT power cables of higher sizes interconnecting PCCs & MCC)
- g) Absence of cross phasing
- h) Firmness of terminations.

2.2.20.0 CODES AND STANDARDS

IS The electrical installation shall meet the requirement of Indian Electricity Rules as amended upto dates, relevant IS codes of Practice and Indian Electricity Act. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding. A list of applicable standards is given below for reference.

Installation of cabling work shall comply with the following Indian Standards (Latest editions) :

- IS 455 Code of practice for installation and maintenance of power cables upto and including 33 KV rating.
- IS 732 Electrical wiring installation (system voltage not exceeding 650 V).
- IS 2274 Code of practice for electrical wiring installations (System voltages not exceeding 650 V)
- IS 4029 Guide for testing of 3 phase induction motors.
- IS 493 Three pin plugs and socket outlets.
- IS 2309 Code of practice for the protection of buildings and allied structures against lightning.
- IS 3043 Code of practice for earthing
- IS 3072 Installation and maintenance of switchgear
- IS 5133 Box for enclosure of electrical equipment
- IS 1653 Rigid steel conduits for electrical equipment
- IS 3480 Flexible steel conduits for electrical wiring

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- IS 2667 Fittings for rigid steel conduits for electrical wiring
- IS 3837 Accessories for rigid steel conduits for electrical wiring
- IS 2062 Specification for structural steel
- IS 3502 Specification for steel chequered plates
- IS 5216 Guide for safety procedure and practice in electrical work
- IS 13947 Degree of protection provided by enclosures for low voltage switchgear and control gear.
- IS 5216 Guide for safety procedures and practices in electrical works.
- IS 226 Structural steel (Standard quality)
- IS 800 Code of practice for use of structural steel
- IS 316 Code of practice for use of metal arc welding for general construction in mild steel.
- IS 1363 Hexagonal bolts, nuts and screws
- IS 1572 Electroplated coatings of cadmium on iron and steel.
- IS 2629 Code of practice for hot dip galvanising for iron and steel.
- IS 2633 Method of testing uniformity of coating on zinc coated articles.

In addition to the standards mentioned above, all works shall conform to the requirements of the following rules and regulations.

- a) Indian Electricity Act and Rules framed thereunder
- b) Fire insurance regulations
- c) Regulations laid down by the Chief Electrical Inspector of State
- d) Regulations laid down by the Factory Inspector of State
- e) Any other regulations laid down by the authorities.

In case any clause of contradictory nature arises between standards and this specification, the latter shall prevail.

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2.2.21.0 GUIDELINES FOR EARTHING INSTALLATION

- 2.2.21.1 All equipments shall be earthed by two separate and distinct connections. Earthing terminals will be available in all the equipment supplied by BHEL.
- 2.2.21.2 The earthing conductors shall be mild steel/G.I. strips/wires. All connections from the equipments to the main earthing conductors shall be made as illustrated in earthing drawings. A copy of earthing drawing shall be provided to the successful tenderer.
- 2.2.21.3 A continuous earthing conductor shall be installed in all cables trays and securely clamped to each tray section by suitable connectors to form a continuous earthing system. When two or more trays supporting power cables run on parallel a continuous earthing conductors shall be provided on one tray only with tap offs to the control cable trays. All valve and damper motor and rapping motors will be earthed to this conductor.
- 2.2.21.4 All joints in the earthing system shall be welded type. Earthing connections to all equipment including motors shall be bolted type.
- 2.2.21.5 Earthing connections shall be free from tinning scale, paint, enamel, grease, rust or dirt at the time of making joint.
- 2.2.21.6 Metallic sheaths, screens/shields and armour of all multicore cables shall be bonded and earthed.
- 2.2.21.7 Earthing conductors along with their run on columns, beams, walls etc., shall be supported by suitable cleats at intervals of 750 mm.
- 2.2.21.8 Conduits shall be bonded together and grounded at all switchgear and control centres.
- 2.2.21.9 M.S.Earthing conductors shall be coated with one coat of bituminous paint, wrapped with a layer of bitumen tape and finally coated with bitumen paint. For site welded GI strips/wires required coat of aluminium paint should be given.

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2.2.21.10 If the equipment is not available at the time of earthing conductor laying tap connections from the main earthing conductor shall be brought out up to slab equipment foundation level with at least 200 mm spare length left for further connections to equipment earthing terminals.

2.2.22.0 GUIDELINES FOR ERECTION OF CONTROL PANELS AND DISTRIBUTION BOARDS

2.2.22.1 Erection

The base frames will be supplied normally along with the boards. These will have to be aligned, levelled and grouted in position as per approved drawings. Wherever the base channels are not available, the same will have to be fabricated and painted at site. Base channels will have to be grouted. All necessary concrete chipping and finishing works are to be completed. Suitable concrete drilling machine shall be used for making hole on the concrete floor.

2.2.22.2 For the panels which are to be mounted on the trenches, channel supports have to be provided across the cable trenches over which the base frames of the panels shall be mounted. Fabrication and erection of these support structures shall be carried out as per drawings.

2.2.22.3 All the panels/board shall be placed on its foundation or supporting structures and shall be assembled equipment as required. All equipment should be installed with parallel, horizontal and vertical alignment by skilled craftsmen.

2.2.22.4 All the boards will be delivered in sections. Necessary interconnection of busbar, bolting of panels, left out panel/interpanel wiring, etc. will have to be done after assembling the panel.

2.2.22.5 The following points shall be checked up during erection

2.2.22.6 Layout of foundation channels.

2.2.22.7 Floor level covered by the panel with respect to main floor level.

2.2.22.8 Location and serial no. panels.

2.2.22.9 Positioning of panels.

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- 2.2.22.10 Verticality of panels and breaker truck to station earth.
- 2.2.22.11 Earthing of panels and breaker truck to station earth.
- 2.2.22.4 Lugs for termination of HT and LT cables.
- 2.2.22.13 Mounting and fixing arrangements all modules.
- 2.2.22.14 Check the operation of :
 - i. Remote control
 - ii. Various required - closing / tripping / alarm / indications / interlocks
- 2.2.22.15 Installation position of instruments and relays
 - Operation of relays and instruments.
- 2.2.22.16 AC / DC supplies for panel.
- 2.2.22.17 Tightness of terminal connections for HT & LT connections.
- 2.2.22.18 Working of ammeters and voltmeters for their entire range and other panel mounted instruments like recorder, indicator etc.

2.2.23.6415 V switchgear tests

- a)IR Test on each pole of breaker
- b)IR test on control circuit
- c)Measurement of contact resistance for all three phases of breaker
- d)Measurement of resistance of the closing and tripping coil of breaker
- e)Checking the close trip operation at 70% and 100% of the rated auxiliary D.C. Voltage.
- f)Checking of interlocks provided and tripping of breaker through relays
- g)Space heater operation check
- h)Opening and closing time check
- i)Control and metering circuit checks.
- j)Primary and secondary injection tests.

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k) Thermal overload relay testing and checking

l) Calibration of all instruments and meters

m) Phase rotation checks

n) High voltage test on 7C.1.3KV switchboard

2.2.24.0 CUTTING & WASTAGE ALLOWANCE

2.2.24.1 The following scrap allowances are permissible:

	non- salvageable	unaccountabl e
1. Length below 0.5 M steel pipes, SS/Cu tubes, Single pair cables	2%	0.5%
2. Length below 20m multi cable, multitubes	2%	0.5%

2.2.25.0 GUIDELINES FOR HANDLING OF SOLID STATE MODULES:

-All the solid-state modules shall be handled by qualified person.

-Electronic modules should only be touched when it is absolutely essential.

-Before touching any electronic modules, the operator should discharge the static electricity by earthing himself or better still, ensure constant discharge by wearing an earthed wrist strip.

-The operator should not wear clothing made entirely from synthetic fibres, but a mixture containing atleast 65% cotton.

-PCB should always be held by the front panel or by the module frame and the electronic components should never be touched.

-The electronic modules should never be placed close to television sets or CRT units.

-Soldering irons and any other tools used must be grounded.

- All modules using CMOs components are packed in antistatic bags, when transported loose to avoid ESD failures. The antistatic bags must always be used to transport modules at site from one place to the other.

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2.2.26.0 GUIDELINES FOR HANDLING AND STORAGE OF ELECTRONIC CUBICLES/ SUB-ASSEMBLIES/ LOOSE ITEMS.

- 2.2.26.1 Immediately after unloading at site, the electronic equipment should be kept in the covered area. Handling and lifting of the package should be done without jerks or impacts. Packing case should not be dripped or slid along the floor under any circumstances. Suitable forklift should be used to move the case to its final position. All the above points are to be strictly followed as the electronic equipments cannot withstand any stress due to vibration and shock.
- 2.2.26.2 After unloading at site, the package of the equipment shall be inspected for external damage. In case the package is damaged, the package number and details of the damage should be noted. The details of the damage should be reported to the responsible site Engineer.
- 2.2.26.3 Cases should be opened/unpacked using correct nail pullers. While opening the planks, care should be taken to see that the equipment is not damaged. Cases should not be unpacked in areas where they are exposed to rain water/liquid splashing, dust or other harmful materials like chlorine gas, Sulphur dioxide etc.
- 2.2.26.4 After opening the case, all supports provided for transport are to be removed with due care.
- 2.2.26.5 Hinged frames should not be opened when equipment is not secured to the floor as this is likely to cause it to topple over. The hinged frame can be opened only if the equipment is still fixed on to the bottom wooden pallet.

Note : The erection, testing and commissioning guide line covered in this tender for all the electrical and C&I equipments are not exhaustive and may or may not applicable for this scope of work. Any other pre-commissioning and field tests not included in tender but necessary as per relevant standards, code of practice and instructed by the manufacturer of the equipment shall also have to be carried if deemed necessary free of cost. The contractor shall take the full responsibility of testing, commissioning, trial run and successful operation of the equipment under overall guidance of BHEL engineer as detailed in the tender.

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Application procedure for Fire Proofing of Cable Trays & Ducts

Fire coverage of minimum half an hour of hydrocarbon fire to ducts without damaging the cables. System undergone type test as per ASTM E-119 / BS-476 /ASTM E 1725 for hydrocarbon fire Test at 1100 Deg. C for a period of minimum 30 min.

Fire proofing system made as per as per below method was tested at CBRI, Roorkee against requirement of cable tray Fire proofing job at IOCL, Panipat under EIL consultant.

- 1) Application of two layers of 25 mm thick, 48 Kg/m³ density FyreWrap Durablanket 'S' with proper overlap and butt joints. Blankets would be tied with 1mm dia G .I. wire.
- 2) Covering the insulation with 26 SWG (0.45mm) thick Aluminum sheet to provide weather protection.
- 3) Aluminum sheet will be secured in position with the help of 10mm / 4 mm S S 304 straps at an interval of approx. 300 mm.
- 4) Overlaps in Aluminum sheet will be sealed with the help of 50mm wide self adhesive Aluminum Tape.
- 5) Care will be taken to prevent any possibility of water and dust ingress into the system.

Application Procedure Fire Sealing Compound

ACE MORTAR SEAL (Fire Barrier)

25 Kgs. Of ACE – Mortar Seal when mixed with 16 litres of water will result in about 36 litres of ready to apply Mortar.

No special surface preparation is necessary. However dusting / removal of any oil substance is recommended.

In case of wall openings, normally only one side of the opening is to be shuttered by using plywood or any other suitable material. However in the case of larger openings, shuttering on the application side will facilitate a more rapid pace of work. The shuttering on the application side shall be moved up with the level of the mortar. In the case of floor openings, only the underside needs to be shuttered. Mortar is filled from the top and levelled out, with a trowel.

The mixed mortar is then applied like normal cement concrete, taking care to fill all the crevices and spaces between the cables. The exposed surface can be trowelled to form a very smooth surface.

The mortar thus installed shall be cured for 5 to 6 days with water.

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DATA SHEET

SPECIFIC TECHNICAL REQUIREMENTS

SUPPLY ITEMS

1. Clamps
 - a. Material & Type : Nylon self locking ties aluminium strips clamps as per Section VI
 - b. Sizes : To meet the requirements of Section VI
2. Ferrules : As per Section VI
3. Tag
 - a. Material : Aluminium/Fibre/Stainless Steel
 - b. Markings : Engraving/Embossing/Printing
 - c. Size : As required.
4. Cable lugs : Copper/Aluminium (crimping type)
5. Clamp Spacing:
 - a. Trefoil Clamps:
 - i. Horizontal run spacing : 1000 mm (max)
 - ii. Vertical run spacing : 1000 mm (max)
 - iii. Axial spacing : Double the diameter of larger cable between adjacent trefoils or 150mm Whichever is less

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Other Clamps

A. Power Cables:

Above 35mm OD

i)Horizontal runs : Individually clamped at 3000 mm Interval (max)

ii)Vertical runs : Individually clamped 3000mm intervals (max).

Upto 35 mm OD

i)Horizontal runs : Collectively clamped at 3000 mm intervals (max)

ii)Vertical runs : Collectively clamped at 2000 mm interval (max)

B. Control Cables:

i)Horizontal runs : Collectively clamped at 3000 mm interval (max)

ii)Vertical runs : Collectively clamped at 3000 mm interval (max)

C. Spacing for cables supported along structure/ceiling

Clamping Spacing:

i)In horizontal runs : 750mm (max)

ii)In vertical runs : 750mm (max)

Spacing between cables : 30 mm (min)

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Note:

- a. Supports shall also be provided at each bend.
- b. For any change in above spacing, prior approval of Engineer will be taken

6. Cable termination:

Type of Lugs:

- a. Power Cables : Copper/Aluminium/Both crimping type
- b. Control Cables : Copper pin type, copper screw type, Direct termination
- c. Special Cables : Pin type, maxi-termi type.

7. Wastage Allowance:

- a. HT cables : 1%
- b. LT cables above 70mm : 1%
- c. LT cables upto 70mm : 1%
- d. Control & Special cables : 1%
- e. Fire Survival cables : 1%
- f. Steel materials (for cable trays/tray support installation) : 1% by weight

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